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Insects

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DIVISION OF ENTOMOLOGY—BULLETIN NO. 36, NEW SERIES.

L. O. HOWARD, Entomologist.

AN INDEX

TO

BULLETINS NOS. 1-30 (NEW SERIES)

(1896-1901)

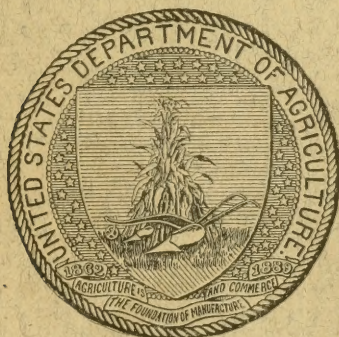
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BY

NATHAN BANKS, ASSISTANT ENTOMOLOGIST.



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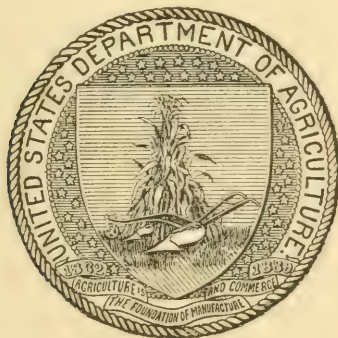
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF ENTOMOLOGY.

Washington, D. C., July 10, 1902.

SIR: I have the honor to transmit herewith manuscript of an index to the Bulletins of the Division of Entomology, Nos. 1 to 30, new series, published in the years 1896 to 1901, and which has been prepared by Mr. Nathan Banks, an assistant in this office. These Bulletins are constantly referred to by experiment-station entomologists and others interested in this subject, and we have frequently received letters asking that such a general index be published. I therefore have no hesitation in recommending its publication.

Respectfully,

L. O. HOWARD.

Entomologist.

Hon. JAMES WILSON,

Secretary of Agriculture.

AN INDEX TO BULLETINS NOS. 1 TO 30 (NEW SERIES) (1896 TO 1901) OF THE DIVISION OF ENTOMOLOGY.

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L. O. HOWARD, Chief of Division.

PROCEEDINGS

OF THE

FOURTEENTH ANNUAL MEETING

OF THE

ASSOCIATION OF ECONOMIC ENTOMOLOGISTS.



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LETTER OF TRANSMITTAL

U. S. DEPARTMENT OF AGRICULTURE,

DIVISION OF ENTOMOLOGY,

Washington, October 3, 1902.

SIR: I have the honor to transmit herewith the manuscript of the Proceedings of the Fourteenth Annual Meeting of the Association of Economic Entomologists, which was held at Pittsburg, Pa., June 27 and 28, 1902. The papers presented at these meetings are always of the highest economic importance, and the present series is of an unusually practical nature. The Department of Agriculture has hitherto published the secretary's reports as bulletins of this Division, and I therefore recommend the publication of the manuscript here presented as Bulletin No. 37 (new series).

Respectfully,

L. O. HOWARD,

Entomologist.

Hon. JAMES WILSON,

Secretary of Agriculture.

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FOURTEENTH ANNUAL MEETING OF THE ASSOCIATION OF ECONOMIC ENTOMOLOGISTS.

MORNING SESSION, FRIDAY, JUNE 27, 1902.

The Association met in the west room of the Carnegie Lecture Hall, Carnegie Institute, Schenley Park, Pittsburg, Pa., at 10 a. m., June 27, 1902.

The following were in attendance at the sessions:

E. E. Bogue, Columbus, Ohio; A. E. Burgess, Columbus, Ohio; E. P. Felt, Albany, N. Y.; G. E. Fisher, London, Ontario; W. J. Holland, Pittsburg Pa.; A. D. Hopkins, Morgantown, W. Va.; L. O. Howard, Washington, D. C.; A. H. Kirkland, Boston, Mass.; William Lochhead, Guelph, Ontario; C. L. Marlatt, Washington, D. C.; Herbert Osborn, Columbus, Ohio; A. L. Quaintance, College Park, Md.; W. E. Rumsey, Morgantown, W. Va.; E. Dwight Sanderson, Newark, Del.; W. M. Scott, Atlanta, Ga.; J. B. Smith, New Brunswick, N. J.; F. M. Webster, Urbana, Ill.

The meeting was called to order by President A. D. Hopkins, who, after calling Mr. E. P. Felt to the chair, delivered his annual address, which follows:

ON THE STUDY OF FOREST ENTOMOLOGY IN AMERICA.

By A. D. HOPKINS, *Morgantown, W. Va.*

In former addresses by presidents of this Association, many different phases of the subject of economic entomology have been discussed. A review of these twelve addresses would be interesting and valuable as a reminder of the many good things presented in each. Even a list of the titles will be suggestive of the field covered, and remind those of us who had the pleasure of hearing the addresses of their striking features and the individual characteristics and special lines of thought and work of the authors:

First. The Outlook of Applied Entomology, by C. V. Riley. Champaign, Ill. 1890.

Second. Economic Entomology, by James Fletcher. Washington, D. C. 1891.

Third. Work of the year in Economic Entomology, by S. A. Forbes (first vice-president). Rochester, N. Y. 1892.

Fourth. The Drift and Balance of our Progress for the Year, by S. A. Forbes. Madison, Wis. 1893.

Fifth. A Brief Account of the Rise and Present Condition of Applied Economic Entomology, by L. O. Howard. Brooklyn, N. Y. 1894.

Sixth. Entomological Notes and Problems, by J. B. Smith. Springfield, Mass. 1895.

Seventh. The Evolution of Economic Entomology, by C. H. Fernald. Buffalo, N. Y. 1896.

Eighth. The Present and Future of Applied Entomology in America, by F. M. Webster. Detroit, Mich. 1897.

Ninth. The Duty of Economic Entomology, by H. Osborn. Boston, Mass. 1898.

Tenth. The *Laissez-faire* Philosophy Applied to the Insect Problem, by C. L. Marlatt. Columbus, Ohio. 1899.

Eleventh. Objects of the Association of Economic Entomology, by C. P. Gillette (first vice-president). New York. 1901.

Twelfth. Life History Studies on the Codling Moth, by C. P. Gillette. Denver, Colo. 1902.

For this, the thirteenth address and fourteenth meeting, the subject of Forest Entomology in America has been chosen for at least two reasons: (1) It deals with a different phase of the science, and (2) it is a subject which will be taken up as a special feature of the work of the Division of Entomology, United States Department of Agriculture, after July 1, 1902.

The primary object will be to discuss some features of the study of forest insects in America in a way which may be of service to the student and young investigator, rather than to attempt to consider the deeper problems for those of you who are already specialists in other branches of entomology.

While forest entomology has received more attention in some European countries, especially Germany, than has any other branch of the science—and forest officials there are required to have special training in the study of insect enemies and methods of combating them—it has been comparatively neglected in America. Indeed, it has only been within recent years that a sufficient need has been recognized to justify giving it special attention. Great monumental works like those of Ratzeburg of Germany, published in 1839–1844, together with the rapid advancement at that time in systematic forest management and government control of forests throughout Europe, inspired a great interest in the subject, and led to a realization of the practical importance of a knowledge of insect enemies of trees in the successful management and protection of the forests. Therefore a knowledge of forest entomology was early recognized in Germany as one of the important features in the training of forest students and forest offi-

cial. Other important contributions followed those of Ratzeburg until there is a mass of published data which is invaluable to the foresters of Europe. But these contributions, valuable as they are to the forest interests of the older countries with long established forestry systems, relate to conditions very different from those prevailing in America. Indeed, they are valuable only to the advanced student and investigator in this country, and are not valuable or specially useful to our young students, foresters, and managers of private estate. In the aggregate there has been much original and compiled matter published in the United States relating to the insects of forest and shade trees, notably by Harris, Fitch, Walsh, Riley, LeConte, LeBaron, Saunders, Lintner, Packard, and others. Within recent years considerable additional matter has been contributed by official entomologists, but up to the present time we have nothing in the line of special instructions in the study of forest entomology that is adapted to present conditions and needs in this country.

The fifth report of the United States Entomological Commission on Forest and Shade Tree Insects is the only important attempt at a general discussion of the subject. This, as stated by the author, was "designed merely to give to the public, especially those persons interested in forestry and the planting and cultivation of shade trees, a brief summary of what is known [up to January, 1888] of the habits and appearance of such insects as are injurious to the most useful kinds of trees."

This work served a most excellent purpose by bringing together in one volume the principal records of observations of forest insects by American entomologists, and has doubtless stimulated others, as it did the present writer, to an active interest in the subject of insect enemies of trees. But it would seem that there is at present a special need of an introduction or guide to the study of forest entomology for the special use of students in forest schools and others who desire general nontechnical information on the subject.

It is, therefore, my object in this address, like the pioneer making a preliminary survey in a new country, to consider the general features of the subject and leave the details to be treated in succeeding contributions as the evolution of the forestry movement in this country indicates the need.

FORESTRY AND FOREST PROBLEMS.

Forestry, which relates to the investigation of forest problems and the management of forests with a view to utilizing their products and perpetuating their resources and beneficial influences, is becoming recognized as a branch of applied science which involves some of the greater economic problems of this country.

It is made a feature of recent messages of Presidents of the United States and governors of some of the principal States. It is the subject of exhaustive Federal and State legislation. Large sums of money are annually appropriated for the establishment and maintenance of National and State forest reserves and parks, and for special research in many branches of science which have a direct bearing upon the utilization and preservation of our forest resources.

Within recent years both public and private funds have been devoted to the establishment of forest schools. Notably to the College of Forestry at Cornell University, the Forest School at Yale, and the Forest School of the Biltmore estate. Courses in forestry have been established in many of the universities and colleges, and it is even proposed to introduce the study into the common and high schools.

There is a notably increased interest in scientific investigations of forest problems manifested by the managers of some of our great railroad systems and by other companies who are extensive manufacturers and consumers of forest products. This is demonstrated by the rapidly increasing demand for special investigations and literature relating to American forests; and it indicates a general appreciation of the value of forests in their relation to public and private interests and the need of their protection.

Investigations within recent years, by the writer, in the hardwood and coniferous forests of West Virginia, the great coniferous forests of the Northwest, the pine forests of the Black Hills reserve, and the spruce woods of Maine, convince him that the depredations by insects on the living timber alone cause injuries amounting to many millions of dollars annually. A study of the insect depredations on forest products, such as railroad and other construction materials, tan bark, and minor products, makes it plain that the actual loss in money and labor amounts to many millions of dollars more each year.

Forest entomology is a branch of economic entomology which treats of insects in their relation to forests and commercial forest products, as distinguished from those which relate to farm and garden plants, and to fruit, ornamental, and shade trees.

While the determination of successful methods of protecting the ornamental and shade trees of private grounds and parks from injurious insects will depend largely upon information contributed by forest entomologists, such trees are, as a rule, grown under different conditions and subject to treatment similar to that applied to fruit trees and cultivated plants, which is not practicable in the forest. The acquiring of information by the forest entomologist involves the determination and classification of the species of forest insects, according to their systematic relations to each other, their relations to the trees they infest, and the economic results of their work; a detailed study of the life history and habits of the more important injurious and beneficial species; a

special consideration of the influences and natural laws which contribute to favorable or unfavorable conditions for their life and work; and the conducting of experiments to determine practical methods of preventing losses from the ravages of the destructive species.

The information to be collected and disseminated is of two kinds: (1) That which is of a technical nature, as contributions to the advancement of science and for the special benefit of students and investigators; and (2) that which is capable of immediate practical application in the management of public and private forests and in lumbering operations.

In addition to a special knowledge of entomology, pure and applied, the student who desires to become a good forest entomologist should have a general knowledge of the science of forest zoology, forest botany, geology, chemistry, physical geography, and economics. It is also important that he have some experience or special training in practical methods of forest management, and knowledge of the manufacture and use of forest products. The universities and especially the forest schools and colleges will give the desired preliminary training in forestry, and works on general entomology, such as those by Harris, Packard, Comstock, Smith, Howard, Sanderson, and other American writers, supplemented by some of the principal foreign works, will fill the requirements for information about insects in general.

After this general knowledge is acquired, together with some training in methods of utilizing published data as guides to methods of study and to the discovery of new facts, the forest will be the school and nature the teacher which will finish the student's course and determine his right to a degree. Indeed, the student who will attain the greatest success in this, or other branches of entomology, will be the one with a natural or acquired ability and love for the work who will seek out the insects in their natural haunts and rely upon and cultivate originality in methods of observation and in collecting and recording data on which to base conclusions.

There is, perhaps, no branch of science which offers greater opportunities for the discovery of new facts and the contribution of valuable information than forest entomology. In this field very little is known compared with what there is yet to be learned. Especially is this true in regard to the life history, habits, and distribution of the injurious and beneficial species. Yet this knowledge is of the greatest importance in determining and applying methods of preventing losses.

There are, indeed, hundreds of subjects and special problems in forest entomology worthy of a lifetime study by as many specialists. There are many families, groups, and genera of insects represented by the principal enemies and friends of the forest which are sadly in need of detailed study by specialists for the accurate identification of the species and a complete revision of the literature. The insects of

the pines and spruces, the cedars, oaks, and hickories, and many others of our principal forest trees, offer excellent opportunities for original investigation and the contribution of information of great importance.

METHODS OF WORK AND STUDY.

In addition to general methods of collecting, preserving, and mounting insects, as given in text-books on entomology, some suggestions may be offered for studying forest insects and for the investigation of their work.

First of all, the student should keep in mind that there are many collectors of insects and many students in general entomology, as well as numerous specialists who are collecting and studying insects of all orders found in the forest and field. Thus he should avoid general collecting, and devote his time to the accumulation of specimens and observation on life histories and habits of insects which are associated with injuries to forest trees or forest products.

In addition to a general study of insects which have some economic relations to forests, he should select, at as early a date as possible, some special subject for detailed study. There is no lack of important subjects, as has already been suggested, but in making the selection the prevailing conditions, opportunities, and facilities in the immediate vicinity or sections in which the studies are to be conducted should be considered. If it is in a pine region, insects affecting pines will offer the most desirable opportunities for study; if in a hardwood region, those affecting the oaks, hickories, chestnut, and the like will offer the best opportunities. If there is some prevailing injury to a given kind or class of forest trees, this will at once suggest itself as the most important to take up. It matters not whether it is the study of the insect fauna of a species or genus of forest trees, the causes of a special class of injuries, or the study of a single family, genus, or species of insect. There is enough in each case to keep the student occupied in original researches for many years, and to furnish sufficient material for contributions to the literature of the subject. Indeed, every student who takes up forest entomology as a life work should start out with the object of acquiring and disseminating as much knowledge as possible on some special feature of the science. To thus become a specialist of this kind does not necessarily imply that he will have a narrow comprehension of the entire subject. Even if one were to try to find out all that is to be known about a single enemy of a forest tree, and every possible method of preventing losses from its work, his work would involve a general knowledge not only of forest entomology in its broadest sense, but of all related sciences and subjects. In fact, as a great thinker has said, in order to know all about any one thing it is necessary to know all about everything. While this may not be literally true, it is becoming recognized that there is almost an unlimited interrelation of all sciences and all subjects.

The equipment for collecting specimens need not be expensive or elaborate. The necessities are: A hatchet or light ax, carried in a scabbard, which may be fastened to a stout belt; a hunting coat, or an ordinary sack coat, with many pockets; a supply of collecting vials of various sizes, fitted with the best cork stoppers; a small bottle of alcohol; a medium and a small cyanide bottle; tweezers; camel's hair brushes; a stout knife with small and large blades; a small saw; a net and umbrella; and last, but not least important, a notebook and pencil. With this equipment, or such part of it as is required for the special kinds of specimens desired, a good observer can go out in the woods any day in the year and find plenty of material.

The best places to collect species infesting wood and bark is along the edge of the woods, or where trees have been girdled or felled a few months previous. Here one will usually find in the bark of the roots, stumps, main stems, tops, branches, and twigs different stages of many species of bark-beetles and bark-inhabiting larvæ, together with their natural enemies and associates; and the wood will yield many more.

Lumbering regions and sawmill yards are especially prolific in specimens at all times, as are also broken branches, individual trees, and groups injured or killed by insects, felled by storm, or otherwise rendered attractive to insects. During the spring, summer, and fall the foliage will yield specimens almost unlimited in number and variety. But one should remember, as has already been indicated, that it is not the number and variety, but those of most importance, that are to be sought out, noted, collected, and studied. It is often better to spend a day in the diligent search for all that can be found in or on a single tree, or in observing and recording in the notebook all that can be found out about a single species, than merely to collect hundreds of specimens or many species without careful records.

Indeed, the proper recording of what one sees at the time the observations are made is of the greatest importance, and is the one thing the student should practice more, perhaps, than anything else.

RECORDING OBSERVATIONS.

While nearly every entomologist has adopted some system of taking and keeping notes on observations in the field or laboratory which is specially adapted to his own line or method of study, and shows marked peculiarities, there are certain general principles and rules which should be laid down for the consideration and guidance of the student and amateur investigator.

In collecting specimens and in field observations the notes taken should include the following: The exact locality (the nearest post-office, hill, mountain, or farm); when possible, the elevation and the exposure; the date; the host plant; point of attack; what stages

occurred, etc. If it is associated with any special injury or trouble affecting the plant or object from which it obtains its food, the fact should be noted. As many details as possible should be briefly or fully noted. Every separate note referring to collected material should be numbered. In regard to the use of numbers, it should be specially remembered that the numbered specimens serve as an index to the notes relating to them. Therefore the same numbers should never be used a second time. The student should start out with the idea of using consecutive numbers as long as he collects insects. At the same time economy should be practiced in the use of numbers, and this can be accomplished in many ways; as, for instance, No. 1 may be made to refer to more than 100 different entries relating to insects collected on the same date and from the same tree. It may be used 26 times with a letter of the alphabet preceding it (as a1, b1, etc.), 26 times more with letters following it (as 1a), 26 times more with a letter over it, and indefinitely with decimals or fractions. The object in view is to adapt the numbers to all requirements without the necessity of repeating or having them attain inconvenient proportions.

If the object in view is simply to get the specimens, then the locality and date, with the collector's name, are all that is necessary to accompany the specimens in the bottle or on the pin. If the student has ambitions, however, to accumulate material and data which will be of the greatest value, he will give special attention to the accumulation of material which represents more than localities and dates. Our museums and private collections are already oversupplied with this kind of material, which is well enough as far as it goes; but the student who would be satisfied to go no further than this had better not enter the field of forest entomology. His place would be in the museum with dead specimens—a place, by the way, where a vast amount of good and indispensable work is done in systematic study and identification of specimens; but this is in the line of pure science, while the forest entomologist's ambition should be to contribute to the advancement of both pure and applied science. He can do this best by recording as many facts as possible about the specimens he collects and observes.

After the student has progressed far enough to be able to accurately identify the principal species as they are observed in the field, very many observations may be recorded without collecting specimens or the use of numbered notes. But this should not be attempted until after years of practical work, and even then it can not be reliable except with such species as are perfectly well known. Observations and records based on field identifications by some of our best entomologists have led to much confusion in literature about some of our common insects. This has been abundantly demonstrated by the writer in a recent study of the types of Scolytidae, described by one of

the best American authorities on the Coleoptera of North America. There are a number of examples where a common enemy of forest trees has been identified from descriptions or from observation in the field as a certain species, and after a great deal has been published under the erroneous names it has been found upon comparison with the types that it was quite a different thing, with different habits from the species to which the name properly belonged; and in some cases what was supposed to represent a well-known species was even found to be undescribed. It will, therefore, be readily seen how important it is for the species we write about to be accurately identified, and how necessary to have a numbered specimen to refer to for future corrections or to send to a specialist for authentic identification.

It is always of the greatest importance to observe the character of the work of the insects when found in their natural feeding or breeding places; and, whenever possible, specimens of the work should be secured for the collection, especially the work of wood and bark boring species and that showing special or characteristic injuries to the foliage, etc.: and each should, as with the insect specimens, be accompanied by the note number.

It is also important for the beginner to collect large numbers of specimens both of the insect and its work whenever the opportunity offers. For, even if there should be more than he needs for his own collection, they may be specially valuable for exchange with other collectors for desirable material from other localities and countries. One of the commonest mistakes made by most young collectors, and, for that matter, many older ones, is the failure to avail themselves of the very first opportunity to collect an abundance of material relating to any desirable species. It must be remembered that because an insect is common at one time or place it does not always follow that it will continue to be so or that it is common in other places. Indeed, the reverse is the rule. A period of great abundance is usually followed by a period of great rarity, or, as has sometimes happened, almost complete extinction.

The collector should be constantly on the lookout for the natural enemies of the principal injurious species. One class of the enemies of insects consists of parasitic Hymenoptera, Diptera, etc., found in the adult larval or pupal stage, associated with their host, the larvæ as external or internal feeders on the larvæ, pupæ, or adults of the injurious species, and the adult parasites ovipositing on or in the victims, or in the bark or other infested parts of the plant. The other class of insect enemies of insects are predatory species of Coleoptera, Hemiptera, Hymenoptera, and other kinds of insects which attack and kill their victims, and either devour them or suck out the liquid parts of their bodies. There are also insect diseases which may be indicated by a white powdery substance on the bodies of the dead

insects, and, whenever numbers of examples are found to be dead or dying, specimens should be collected and submitted without delay to some specialist on this class of diseases.

METHODS OF COLLECTING AND REARING LIVING MATERIAL.

It is always desirable to collect living material to rear or breed for the purpose of securing data on life histories and habits. This will consist of eggs, larvæ, and pupæ of foliage-infesting insects to be reared in breeding cages; also bark, wood, branches, and twigs infested with immature stages, to be reared to adults in breeding jars, boxes, or cages.

Specimens from the foliage should be collected in small tin boxes, together with a small amount of their natural food. Some of the smaller things may be reared in the boxes in which they are first collected, if supplied from time to time with fresh food material, while others must be transferred to breeding cages or larger tin boxes. Living specimens in wood or bark are easily collected in sections cut from the infested parts of the plant, and carried in the larger pockets of the hunting coat; or, if a long distance from the laboratory, they may be packed in bundles or boxes and shipped by the most convenient method available.

For breeding specimens from this kind of material, the writer has secured excellent results by the use of different-sized fruit jars with clamp covers. The screw-topped jars are also very convenient for this purpose. For very large sections, or a large amount of material of one kind, tight barrels or large wood or galvanized-iron boxes may be used to advantage.

For carrying on the more elaborate work of rearing from wood and bark, a specially constructed insectary is necessary. Wood and bark infesting larvæ and pupæ, and parasitic larvæ in cocoons, may be successfully reared to adults in bottles or vials which are just large enough to accommodate single specimens. These small vials with cork or cotton stoppers are indeed specially convenient for the rearing of parasitic larvæ and pupæ taken from the mines or pupa cases of the wood or bark-inhabiting host.

PRESERVING, MOUNTING, AND LABELING SPECIMENS.

The specimens that are killed in 25 per cent alcohol should be removed from the bottles in a day or two after they are collected, then cleaned thoroughly and replaced in clear 80 or 90 per cent alcohol. The specimens killed in the cyanide bottle should be gone over, separated, and either mounted or stored where they will be free from museum pests.

The specimens of work of insects should have the surplus parts removed, and should be labeled and stored where they will be readily

accessible for future reference. Broad shallow drawers or trays are convenient for the smaller wood and bark specimens, while wood or heavy paper boxes serve for larger ones. Common florists' paper boxes, which are shipped flat ready to be made up, are excellent for storing the classified material.

Every individual specimen should have the number of the note referring to it, or the series to which it belongs, and also something to designate the particular set of notes or accessions catalogue to which the number refers, as "500, Hopk., W. Va.," which means entry No. 500 in the accessions catalogue of the entomological department of the West Virginia Agricultural Experiment Station, Morgantown, W. Va., A. D. Hopkins, collector. As long as the specimens remain in the collection with the catalogue these accession numbers are all that is necessary for the duplicate material, since they serve at once as index to the readily accessible notes. If, however, any of the specimens are transferred to other collections they should always bear labels showing date, host, and such other facts as are of primary importance to preserve their identity, or if a large number of examples of different species are sent a list of species and accessions catalogue numbers with extracts from original notes should accompany them, together with the address of the individual or institution having permanent charge of the accessions catalogue.

The specimens of the work of insects may have the number and other data written on them, or on paper labels and pasted on or otherwise attached. If the specimens are fastened on cardboard or to the bottom of the case, labels may be printed and pasted beneath them.

WHAT TO STUDY.

After the student has acquired some knowledge of how to study, collect, and make proper records of observations, and how to label and preserve specimens, it is important for him to consider well what there is of importance to study and investigate, and how to get results of practical value. Forest entomology embraces only such insects as are in some way related to human interest in forests and forest products. Therefore, the student must confine his studies to the insect fauna of the forest growth which is of some economic importance, with the view to determining which kinds are injurious, which are beneficial, and which are neutral in their relation to the life history of the plant and the future usefulness of its products.

Commencing with the matured seed or fruit of trees, such as the oaks, hickories, walnut, and others, we find that not only the nut or seed, but its envelope (hull or pod), is the home of many kinds of insects. On the tree, fallen, stored for use, or planted in the ground, they support some different kinds of insect enemies or guests, as they do, also, from the time the seed bursts open and the roots and stem

begin to form through all stages of the seedling, the sapling, the young, matured, old, dying, dead, and decaying tree. Not only does the tree, during each stage in its life history, death, and decay, support some kind or kinds of insects peculiar to each, but every part—the rootlets, the larger branching roots, the main roots, the lower stem, the upper stem, the large and small branches, the twigs, the buds, the young leaves, the flower buds, the different parts of the flower, and the embryo fruit—will have its special guests. Some kinds inhabit the outer bark; others, the intermediate or inner bark, the cambium, the outer or inner sapwood, the heartwood, or the pith.

Not only during its life, but from the time it dies until it is entirely decayed and converted into humus, a tree supports many and varied forms of insect life. Some are its enemies, some its friends; others, neither enemies nor friends, but guests and scavengers. Among its enemies some have special designs upon its life in order that its dying may furnish favorable conditions for the rapid increase of the insect progeny, and consequent increased power in numbers to attack and kill other trees. Some are enemies only to the extent of causing injuries to the roots, bark, wood, branches, and foliage which may be detrimental to its perfect development or its future usefulness to man, but have little or no immediate effect upon its vitality. Others are enemies only so far as they obtain their food from some living part, yet do no permanent injury, such as certain kinds of leaf-eating, sap-sucking, and gall-making insects, which are never or rarely common enough for special harm. There are many other kinds which obtain their food directly from the dead parts of the living tree, such as the outer bark, dead twigs and branches, dead wood, etc., which can scarcely be considered as enemies of the living tree. Among the friends of the living tree are the insects which feed upon the injurious kinds, either as internal or external parasites, or those which attack and devour their prey. Among the guests of the injurious and beneficial inhabitants of the tree there are many kinds which live in the burrows and feed upon the sap, borings, excrements, dead insects, etc., while there are many other kinds which utilize some part of the tree or the burrows of other insects as hiding or hibernating places.

THE INSECT FAUNA OF FOREST PRODUCTS.

The natural products, such as nuts, medicinal roots, bark, and leaves, tan bark, etc., each, under certain conditions of storage and age, furnishes feeding and breeding places for many kinds of injurious, beneficial, and neutral species. The manufactured or commercial wooden products of all kinds, the crude round or square timbers, lumber, staves, hoop poles, etc., are, under certain conditions, subject to attack or serious injury from various kinds of insects while in the woods or

when stored in yards and factories. The seasoned and finished products, especially those from sapwood, may be infested and destroyed by a number of species of so-called powder-post beetles. Construction timbers and lumber, either before being utilized or while in the structure, are subject to injuries by many injurious and other species. The old lumber and timbers of barns and outbuildings, old log and frame dwelling houses, are also infested and injured by forms which are peculiar to such material.

THE ECONOMIC RELATION OF INSECTS TO FORESTS.

The preceding references to the insect fauna of forest trees and their products are suggestive of the vast numbers of kinds, groups, and societies of insects and the kind and character of injuries to be studied. This leads us to a consideration of the economic relation of insects to American forests under the varying conditions which prevail before and after the country is settled and its resources developed.

The relation of injurious insects to the primitive forests.—The relation of insect enemies of a forest before its resources are available to civilized man is of little or no economic importance. They are simply factors in the general struggle for existence between insects and trees, and between the individuals of the forest community in which the destruction of an individual tree by insects is a benefit to other insects and other trees. If a matured or old tree is killed, it gives more room for the development of the younger and more vigorous ones. The injured, declining, and old individuals furnish breeding places for successive communities of insects, which contribute to their death and rapid decay. Thus the young tree growth is favored by light and plant food, and soon fills up the vacancy. Invasions of destructive insects may cause the death of one kind of tree growth over vast areas. This favors the enormous multiplication of the insect fauna until the destructive species perishes for lack of food supply, or from the multiplication of its natural enemies. This proves to be a calamity to the other insects which have depended upon the destructive species to furnish, in the dying and dead trees, the required conditions for their existence. The dying and dead trees and the fallen and decayed branches, bark, and roots contribute to a more vigorous reproduction, so that the forest found by the pioneer settler has lost nothing from its insect enemies.

The relation of the insect enemies of trees to the pioneer settler in a forested country may be more beneficial than otherwise, so far as his immediate needs are concerned. The forest must be cleared from the land that is desirable for agricultural purposes, and in this process the depredating insects may be decidedly beneficial. They contribute to the death and rapid decay of the girdled trees in the clearings and hackings. Invasions which cause the death of the large timber over

great areas may be utilized to the especial advantage of the agriculturist, and contribute to the prosperity of the community of settlers. The dead trees, with the fallen tops, furnish the most favorable conditions for the process of clearing by fire. It saves the expense of girdling. Often the flint and tinder or the torch was all that was necessary to start a conflagration which effectually cleared the land of dead and felled timber, and killed the remaining living trees and young growth.

The relation of insect enemies to the forest of a settled country.—The great destruction and waste of the best of the forest resources necessary to the progress of civilization finally reaches a stage at which the forest is more valuable for its commercial products of timber, its protection of springs and head-water streams, than is the land for agricultural products. Thus as time progresses the insects become more and more injurious in their relation to the public interests. The destruction of matured timber by insects comes to be recognized as a serious loss. Their burrows in the wood of living and dead standing timber and that felled for saw logs and other purposes are recognized as serious defects which reduce the profits of the manufacturer and increase the prices of the clear product to the consumer. The injuries to the young growth which result in the development of a deformed, worthless tree become an element of future financial loss. The areas of dead timber killed by insects become a menace to the forest, furnishing as they do favorable conditions for the outbreak of destructive forest fires and the development and spread of wood-boring insects.

While the more destructive kinds of bark-boring insects may aid in the death of girdled trees, such trees at the same time furnish favorable conditions for the rapid multiplication of the insects and thus contribute to destructive depredations on the valuable living timber in the adjacent forests.

As the merchantable timber and the manufactures of wood become scarcer and the price to the consumer increases, the depredations which a few years before would have remained unnoticed attract more and more attention, and the need of methods of preventing losses from this source is fully realized. Then requests are made for information relating to the kinds of insects that cause the troubles and the details in their habits which is necessary in order to successfully combat them.

Their relation to the public and private forests and farmers' wood lots.—The relation of injurious insects to forests which are under systematic management present quite a different problem from those relating to more primitive conditions. In dealing with the latter there is little opportunity for the practical application of a knowledge of forest entomology, but the former present economic problems worthy of special study and investigation. All of the injurious species may be considered in this relation as enemies, not only to the forests but

to public interests. The introduction of forestry methods offers opportunities for the adoption of methods of preventing much of the losses which under previous conditions could not be avoided. It also offers opportunities for extended research and experiments for the determination of the more important facts relating to the habits and life histories of the insects and their depredations, which will lead to the discovery of improved methods of control.

THE KINDS AND CHARACTER OF THE WORK OF INSECT ENEMIES OF THE FOREST.

The fruits of forest trees are injured by the adults and larvæ of species which feed upon the pulp, pod, or other covering, and thus destroy the seed or prevent its normal development. The seeds are injured or destroyed by beetles and their larvæ, by the larvæ of moths, and by gall-making insects. Nuts of all kinds and the hard fruit of many trees are infested by larvæ from eggs deposited in the growing fruit by small beetles. The entrance of the young larva through the young, tender hull or outer shell heals over so that the ripe nut shows no trace of it. The larva feeds on and destroys the germ and kernel and, when fully grown, bores its way out and enters the ground, where it goes through the transformations and emerges as an adult next year in time to deposit its eggs in the young nuts. Thus the seeds of some trees may be so completely destroyed that few remain for reproduction. This may cause considerable expense and loss to the forester, both in adding to the expense of collecting a sufficient quantity of sound seeds and in causing an uneven stand in the nursery on account of the damage to the stored and planted seeds. This class of injuries also causes a serious loss of the commercial product of chestnuts, hazelnuts, hickory nuts, etc.

The seedling in the forest or in the nursery row is attacked and injured by many kinds of insects. The roots are eaten by the larvæ of beetles and the sap sucked out or poisoned by root-lice. The stem is attacked by wood and bark-boring beetles and grubs. The foliage is devoured by caterpillars, larvæ of sawflies, and grasshoppers, or injured by plant-lice, scale insects, leaf-hoppers, and leaf-bugs. The twigs are injured by twig girdlers, twig miners, scale insects, and plant-lice. As a result, the seedling may either be killed or become stunted or deformed.

The young tree is in a like manner attacked and injured or killed by one or more enemies of the roots, stem, or top. The principal injuries, however, which are characteristic of the growing tree, are those made in the roots and base of the stem by the great root borer, and in the wood of the main stem by the carpenter worms and other borers, which are capable of working in the wood of living healthy trees. While this class of enemies may have little or no direct effect upon the vitality of the trees infested by them, they cause a great loss

of commercial products. Their burrows cause defects in the wood, and are the means of starting decay, which renders the heartwood worthless for commercial purposes. The living bark may be attacked by bark-boring grubs in sufficient numbers to seriously affect its vitality, so that it will soon succumb to the attacks of other insects or diseases.

The mature tree suffers most from the many wood-boring beetles and grubs. The destruction of some of the larger roots by the great root borer causes dead branches and dead tops. The borings of the carpenter worm and other borers in the main trunk, top, and larger branches result in rapid decay, hollow trunk, and generally worthless condition, while its weakened vitality makes the tree an easy prey to destructive bark-boring enemies. The trees blown down by storm or felled by the ax are attacked by a vast number of species of insects. Some live in the bark, where they do little or no harm to the commercial product, but certain kinds may thus multiply rapidly and attack the standing timber. The wood, however, may be seriously injured by many species of wood-boring beetles and grubs which breed only in the wood of dead and felled trees.

Old dead, standing, and felled trees and old logs and stumps are infested by many insects which not only contribute to the rapid destruction of the wood, which otherwise might have some commercial value, but certain kinds breed in such material and emerge to attack the wood of recently felled trees and injured places in the standing living ones. They also attack square timbers in bridges, trestles, railroad bed, etc.

SOME OF THE PRINCIPAL INSECT DEPREDATIONS IN THE FORESTS OF THE UNITED STATES.

THE PINES.

Between 400 and 500 species of insects are known to inhabit the living, dying, and dead pines of the United States. The pine forests of the East, Northeast, and Southeast have suffered and are now suffering greatly from the ravages of destructive bark-beetles. A few years ago (1890-1892) a trouble spread over an area of 75,000 square miles in the Middle Appalachian region which resulted in the death of millions of pine trees. This included all of the indigenous and some of the introduced species in the forests, private grounds, and parks. Upon careful investigation, this trouble was found to be caused primarily by the ravages of a single species of bark beetle (*Dendroctonus frontalis* Zimm. var. *destructor* Hopk.). Previous to 1890 this was a rare insect in collections, and nothing was known of its habits. It disappeared and the trouble ceased in 1893. This insect is liable to appear again in destructive numbers. It is therefore of the greatest importance that special efforts be made to determine the sections in the Eastern and Southern pine forests where it may yet survive, so

that measures may be taken, by introducing or encouraging its natural enemies or by girdled trap trees, to prevent its multiplication and future destructive invasions.

Recent investigations in California, Oregon, Washington, and Idaho, by the writer, under the auspices of the Division of Entomology, United States Department of Agriculture,^a revealed the fact that the western yellow pine, Jeffery pine, sugar pine, mountain or silver pine, shore pine, and lodgepole pine has each its peculiar insect enemies, some of which are very destructive. Many of the finest examples of yellow pine were found to be dead or dying from the ravages of the western pine destroyer (*Dendroctonus brevicornis* Lec.) from northern California to northern and western Idaho. The mountain pine in northern Idaho and western Montana suffered severely from the ravages of the mountain pine destroyer (*Dendroctonus monticola* Hopk. MSS.). The yellow pine has also suffered greatly in Idaho and eastern Washington from the larvæ of a white butterfly (*Neoplusia menapia* Feld.), which defoliates the trees over large areas.

Recent (September, 1901) investigations in the Black Hills forest reservation revealed the fact that a vast amount of the best timber on many thousands of acres has died within the past six or seven years and is yet dying from the ravages of the pine-destroying beetle of the Black Hills (*Dendroctonus ponderosæ* Hopk. MSS.).

It is also reported that the pine is dying in other sections of the Rocky Mountain region, from Idaho to Arizona, evidently because of the ravages of bark beetles.

It is evident from observations made in the Black Hills reservation and in the forests of Idaho, Washington, and Oregon that the death of the pine timber over many extensive areas, supposed to have resulted from fires, was primarily due to the work of tree-destroying insects. Even the meager knowledge we have been able to acquire during hurried investigations in the forest and from observations along the routes of travel through the Rocky Mountain region, the Pacific slope, and the Northwest makes it very plain that the destruction of pine timber, due primarily to the ravages of insects, has been progressing during the past half century at a rate far beyond that conceived by the casual observer or even by those who are making a study of the forests and forest conditions of those regions. Indeed, the extensive ravages of insects on the pines of the United States furnish a problem whose great importance and magnitude would justify the expenditure of large sums of money for detailed investigation by specially trained forest entomologists.

THE SPRUCES.

The spruces of this country are also inhabited by many hundreds of species of insects.

^aBul. No. 21 (n. s.), Division of Entomology, U. S. Department of Agriculture.

The Red Spruce of the middle and northern Appalachians, from West Virginia to northern New York and on through northern New England to Canada and New Brunswick, has, from time to time during the past century, suffered severely from troubles, some of which are known, and others believed to be, caused by bark-beetles.^a

A large amount of spruce was killed in West Virginia about 1885, evidently by a bark-beetle, but the trouble was not investigated until 1890, so the exact species deserving the blame could not be determined.

In 1892 the destructive pine bark-beetle spread in West Virginia from the pine into the spruce, and caused the death of a large amount of the best timber.

The great destruction of spruce, which has attracted so much attention from New York to New Brunswick, was found, upon special investigation, to be largely if not entirely due to the primary attack of the spruce-destroying beetle (*Dendroctonus piceaperda* Hopk. MSS.).^b

The Sitka Spruce of the Northwest has numerous enemies, among which the Sitka spruce *Dendroctonus* (*Dendroctonus obesus* Mann.) is the principal depredator in the bark of living and declining trees, while the spruce-destroying spanworm (*Philecia punctomacularia* Hulst.^c) may be considered as the greatest insect destroyer of forests of this tree and the Western Hemlock.^c Scarcely anything is known about the life history and habits of this insect. Therefore it presents a problem of special importance for investigation.

The Engelmann Spruce has a number of insect enemies, one or two of which are capable of causing wholesale destruction.

Vast quantities of dead spruce occur in different sections of the Rocky Mountain region which, it would seem, bear no trace of having been killed by fire, and the cause will probably be found to be the attacks of some destructive bark-beetle or defoliating insect.

THE HEMLOCKS.

The Eastern Hemlock has a serious enemy in the hemlock destroyer (*Melanophila fulvoguttata*), which has caused the death of a large amount of hemlock timber throughout the Appalachian and North-eastern regions.

The Western Hemlock has at least three destructive enemies of the living trees: (1) The Western hemlock bark-borer (*Melanophila drummondii*), which is closely allied to the Eastern species, and like it extends its burrows beneath the bark and either kills the trees or causes serious gum-spot defects in the wood; (2) the Douglas spruce

^aBuls. 17 and 56, W. Va. Agr. Expt. Station, and Bul. 28 (n. s.), Div. Entom. U. S. Dept. Agr.

^bBul. 28 (n. s.), Div. Ent., U. S. Dept. Agr.

^cBul. 21 (n. s.), Div. Ent., U. S. Dept. Agr., 1899, p. 18.

bark-borer (*Asemum nitidum*), which has similar habits to those of the hemlock bark-borer; and (3) the Sitka spruce spanworm, which defoliates and kills the trees over large areas.

THE CEDARS.

The *California Redwood* has a special enemy in the sequoia bark-beetle (*Phlaeosinus sequoiae* Hopk. MSS.)

The *Giant Arborvitae* has an enemy in *Callidium jaanthinum*, and the Eastern Arborvitae one in *Hylotruxes ligneus*, which infest the living trees and either kill them or cause serious defects in the wood. The other true cedars, the Monterey Cypress, and some of the Western and Eastern junipers, have a number of bark- and wood-boring enemies, which are more or less destructive.

THE FIRS.

The Western, grand, noble white, and Shasta firs, and the Eastern balsam firs are attacked by several destructive bark-beetle enemies, which either kill the trees or cause serious gum-spot defects or decayed places in the wood.

THE OAKS.

The insect fauna of the oaks is very large, probably exceeding in number of species that of the pines. Those noted for their especially destructive attacks on living trees are the carpenter worms (*Prionorystus* spp.), which bore into the bark and wood and not only cause serious worm-hole defects, but by successive attacks cause the death of part or all of the tree. Their burrows give entrance to wood-decaying fungi which soon render the heartwood worthless for commercial purposes. The giant root-borer (*Prionus laticollis*) is another enemy of Eastern oaks in general, which is enormously destructive to large and small trees in forest, park, and lawn; but it would seem that its work is rarely recognized, and that the magnitude of the damage is not generally understood. The large, white, elongate grubs bore in the roots and bases of the trees, causing one or more of the larger roots to die. These holes and the burrows made by the carpenter worms give entrance to other wood-boring insects and wood-destroying fungi, which rapidly extend and complete the destruction of the injured parts. This decay often extends into the base of the trunk, destroying the heartwood and thus causing the tree to be hollow and worthless. The decayed wood of the roots and base of the tree also furnishes fuel for forest fires, so that the trouble started by the giant borer, and extended by other insects and fungi, is made conspicuous by a great blackened wound, which is more often than otherwise supposed to be due to fire alone. Trees are often killed outright by this root destroyer, but the work is usually so obscure that the trouble is often blamed to

other bark and wood-boring insects, which attack the tree as soon as it manifests weakened vitality.

The two-lined chestnut borer (*Agrilus bilineatus*) is another enemy of medium to large white oak and other oak and chestnut trees, which has caused the death of a large amount of this kind of timber throughout the Appalachian region.

The oak timber worm (*Eupsalis minuta*) is one of the most destructive enemies of the wood of living, dying, dead, standing, and felled trees. It causes what is known as pin-hole defects. The loss of the more valuable timber of the largest and best trees caused by this insect is enormous; indeed it is far beyond the conception of persons who have not given special attention to the subject. The ravages of this insect do not end with living and dead trees, but it continues its work in lumber and square timber from infested logs, and will even attack freshly sawed and closely piled oak lumber. This insect alone furnishes one of the big problems for detailed investigation.

The Columbian timber beetle (*Corthylus columbianus* Hopk.) causes one of the commonest defects in white oak lumber and square timber. It attacks and breeds in the sapwood of living trees, and the healed-over wounds cause pin-hole and stained-streak defects.

A serious trouble has for many years affected the oaks of the northern United States from New York to Minnesota, and has caused the death of a vast amount of timber in lawns, parks, and the forest. This has not been specially investigated, and therefore little or nothing is known regarding the primary cause.

THE CHESTNUT.

The living chestnut trees throughout the Appalachian region, and apparently wherever this tree grows, have a most destructive enemy in the chestnut timber worm (*Lymantria sericeum*). This wood-boring worm or grub hatches from eggs deposited in the slightest wound in the bark and surface of the wood, and burrows deep into the heart-wood, causing the wood of nearly every old tree to be perforated with pin-hole defects. It attacks and breeds in dying, dead, and felled trees and stumps, and will continue to work for a time in square timber, telegraph poles, and heavy timber cut from infested trees. It also infests red oak, and often renders worthless parts of the trees which otherwise would make the highest grade timber. The enormous damage to the forest resources of the United States caused by this insect makes it one of primary importance to take up for detailed study and for exhaustive experiments with different methods of reducing the numbers of the pest and preventing losses from its ravages. The giant root-borer and the two-lined chestnut borer also attack chestnut, and in some sections do great harm.

The hickories of lawns, parks, and forest have suffered from time to time within the past half century from the destructive ravages of the hickory bark-beetle (*Scolytus 4-spinosus*) from Missouri to northern New York and West Virginia. Recent investigations and extensive experiments with felled and girdled trees indicate that this pest can be controlled so that under a system of improved forestry management little or no loss should result from its attack.

The poplar, tulip, beech, birch, and, in fact, all of the principal forest trees have their special insect enemies, which attack the living trees and are more or less destructive to their lives or to the commercial value of their timber products.

DEPREDATIONS IN THE WOOD OF DYING, DEAD, AND FELLED TREES,
TIMBER PRODUCTS, CONSTRUCTION TIMBER, AND STORED PRODUCTS.

In addition to the primarily destructive enemies of living forest trees, there is a host of enemies of the wood of the dying and dead standing and felled trees of all species, which cause serious defects and rapid deterioration. Many of these injuries to the wood present problems of great economic importance and most promising lines of investigation in the possibilities of discovering simple methods of preventing losses.

Construction timbers.—There are a number of wood-boring insects which attack and breed in heavy construction timbers, especially those used for railroad ties and in culverts, trestles, and bridges. These are not only weakened by the borings of the insects, but entrance is given to wood-decaying fungi, which work so rapidly that, before it is realized, certain parts may be rendered exceedingly dangerous. Therefore, the relation of the combined effects of insects and fungi to accidents from the collapse of buildings and railroad structures is a subject of special interest and importance for detailed study.

Stored forest products.—Insect depredations on stored forest products, such as tan bark, hickory handles, buggy spokes, and hoop poles, is another problem coming within the range of forest entomology which demands special attention. Recent investigations of insect enemies of stored tan bark have revealed the fact that both oak and hemlock bark are subject to attack by at least five species of insects, which convert into fine powder the inner or flesh part of the bark that has been stored over two or three years. As much as \$70,000 worth of hemlock bark was found to be infested at a single tannery in West Virginia, and personal investigations at other tanneries in the State, together with information from other States, indicate that this is a widespread trouble in the East and North and evidently extends into Canada.

The destruction of stored hickory, oak, maple, and other hardwood lumber, and the various products manufactured from hard woods, due to the ravages of powder-post beetles (*Lyctus* spp.), is a widespread trouble in this and other countries, and has caused the loss of a vast amount of valuable material. Yet comparatively little has been done in this country toward a detailed study of the problem and the elaborate experiments necessary to determine methods of preventing attack.

THE INTERRELATIONS OF INSECTS, FUNGI, AND FIRES IN THE DESTRUCTION OF FORESTS.

This is another problem that recent investigations have demonstrated is one of very great importance. Heretofore it has been almost entirely overlooked, and much of the destruction which has been going on in all of the great forest areas of the country that is primarily due to insect attack, and secondarily to fungi, has been attributed to forest fires, which really occupied third place among the destructive factors.

The examples of destructive insect ravages mentioned here are only a few of a long list that could be given. They should be sufficient, however, to indicate the number and the magnitude of the problems in forest entomology, which, on account of their special economic importance, should be thoroughly investigated.

The need of exhaustive study of these problems is all the more apparent when it is realized that comparatively nothing is known of the more important facts relating to the life history and habits of some of the principal depredators, the conditions that contribute to sudden and destructive invasions, or those that bring about an equally sudden ending of a serious trouble. Without this knowledge little or nothing can be done toward the recommendation of effectual methods of preventing losses. Enough has been determined from a detailed study of some of these problems to indicate quite clearly that a better knowledge of some of the fundamental facts will lead to the adoption of simple, inexpensive methods by which the loss of a vast amount of timber and timber products may be easily prevented.

REMEDIES AND OTHER METHODS OF PREVENTING LOSSES.

The problem of controlling insect enemies of forests is quite a different one from that relating to the control of farm, garden, and fruit and shade tree insects. Indeed, they must be considered from a different standpoint—that of prevention rather than that of destruction. Thus every separate trouble caused by different insects or the troubles caused by the same kinds of insects in different sections of the country must be studied separately with a view to determining methods of

utilizing some method of management specially adapted to the prevailing conditions in each case, which will reduce the number of the depredators or otherwise prevent losses.

SOME PRACTICAL RESULTS.

A few examples may be given of the practical application of a knowledge of some of the principal facts in the life history, as follows:

The recent determination that the tanbark-destroying insects do not attack the stored bark until it is two or three years old suggested a simple method of preventing losses.

The determination that the spruce-destroying beetle attacks only the larger trees, and that the beetles could be attracted to trees hack-girdled during the proper period in June, suggested important methods of forest management and lumbering operations, which will contribute to the elimination of trouble from this pest.

Girdling and timber-cutting experiments have demonstrated the possibility of preventing losses from the ravages of insects and wood-destroying fungi by girdling and cutting timber when the physiological conditions are such as to render the bark and wood unattractive to the depredators or unfavorable for their destructive work.

A knowledge of the habits and characteristic work of bark-infesting insects in living, dying, and dead trees furnished conclusive evidence that a large amount of healthy, uninfested, living timber had been cut in the Black Hills forest reserve, where it was intended that none but trees infested by the pine-destroying beetle or those killed by it or other causes should be cut. It was also demonstrated that a knowledge of the principal facts relating to the primary and secondary insect enemies of the pine of this region would facilitate the drawing up of timber-cutting contracts which would avoid much future trouble and litigation relating to the interpretation of references to insect and insect-killed timber.

Facts determined relating to the habit of the pine-destroying beetle of the Black Hills and the relation of other insects and fungi to the trees injured and killed by it suggested methods of future management which would prevent the loss of much timber, and contribute to a better public appreciation of the importance of Government forest reserves and the adoption of scientific forestry.

The facts which have been recently determined from special investigations of the troubles caused by the destructive pine bark-beetle, the chestnut timber worm, the oak timber worm, the giant root-borer, and a number of other principal enemies of Eastern forest trees have made available a fund of information which it is believed can be used to special advantage in formulating future plans for the management of Eastern forest reserves, systematic forestry work, conservative lumbering, etc.

The new facts determined during recent investigations in Cantornia, Oregon, Washington, and Idaho relating to the habits of the destructive enemies of the redwood, Monterey pine, Western yellow pine, sugar pine, Jeffery pine, shore pine, mountain pine, and lodgepole pine, and the Western hemlock, Douglas spruce, Englemann spruce, several species of fir, the Western larch, and Western cedars, have made available a fund of information which will be of special service in future studies of the enemies of the principal forest trees of the Western forest reserves.

The extent and magnitude of depredations by insect enemies of the forests and forest products of this country; the comparatively meager knowledge of the essential features in the life history, habits, and natural enemies of the principal depredators on which to base conclusions relating to methods of control or prevention; the possibility, as has been demonstrated, of future detailed investigations leading to the discovery of methods of preventing a large part of the losses; the facilities afforded in the extensive Government reserves and in large private areas where systematic working plans and forest management have been adopted, together with the information available from the results of investigations in this country and Europe, seem to warrant the recognition of forest entomology as a distinct branch of economic science.

The address was most heartily received, and, on motion of Mr. Howard, Mr. Hopkins was voted the thanks of the Association for his able presentation of this very important subject. The discussion of the address was postponed until the opening of the afternoon session and the regular business of the association was taken up. The discussion, however, is here inserted in connection with the address for the sake of continuity.

Mr. Smith stated that he had been much impressed by the address. He thought the subject one of the most important in its way in the United States, and the presentation of much value to entomologists. He knew that there was much injury done to forest trees by insects, but some things in the address impressed him as being contrary to his own experience, especially the statements about the giant root-borer (*Prionus laticollis*). In his experience, though that insect appeared quite generally in oak forests, he had not found it in that tree. According to his observation an old pine log was almost certain to become infested by the larva and to become its home. He had a large amount of material showing this. The line of work followed by him was quite different from that followed by Mr. Hopkins, and he would place the damage done by forest fires far ahead of that done by insects. Mr. Smith considered that in New Jersey the insects followed the

fires. In that State forests are not in as large areas as in many other places, but in comparatively small blocks. Most of the fires are caused by sparks from the railroads, and after that the insects come in and complete the work done by the fires. Mr. Smith's point was not that Mr. Hopkins had been incorrect in his statement, but that what he said was contrary to his own observations in other localities. However, the facts may be different under different conditions. There was one insect in hickory (*Agrilus* sp.) that he had found cutting off the branches. It would work up and down for a little time under the bark, and would then start around the branch and make galleries to the center, until it had actually cut it off. Only recently he had found a number of specimens that had been cut off in this way.

Mr. Hopkins stated that in his investigations of oak trees he had found the giant root-borer to occur around the roots, and had dug them out in large numbers from living as well as dead tissues.

Mr. Smith stated that he had found them in the roots of cherry trees, working in something like the way described by Mr. Hopkins. According to his observations, except in the case of the blackberry, this insect would not breed in entirely living tissue; and he always assumed that, wherever borers were found in the roots of trees, the roots had been injured by some other cause. The insects are very common in pine logs in southern New Jersey.

Mr. Smith further stated that another point which had interested him was in reference to the carpenter worm (*Prionocystus robiniae*). It was stated to be a very common insect in the scrub oaks. In southern New Jersey, in the second growth from 6 to 8 inches in diameter, the larvæ got in year after year at the same point. They enter by preference at the place where other insects have made their entrance. If the tree is cut down, one can readily determine the time when the first insect entered. Comparatively small additional borings are made to the original one by succeeding broods. He had made sections in some cases that seemed to indicate that the tree had been infested for at least thirty years. He had found small larvæ working out from the end of old galleries. He thought this case offered a good illustration of the resisting power of trees. Those oaks that were most generally infested had certainly stood up for years under the attacks of the borers. He had noted several interesting cases, showing the relation between the woodpecker and carpenter worms, which indicated that sometimes there may be two woodpeckers after the same larva, and there were many cases where the history of these occurrences have been written out in the tree.

Mr. Felt stated in this connection that he had observed in the parks in Buffalo that the carpenter worm was very common in ash trees and in some sugar maples in St. Lawrence County, and in each instance they went to the heart of the tree. He was inclined to agree with

Mr. Smith that successive generations increased the length of the burrows. He had never seen a case of trees attacked by this insect being broken off by winds. He questioned if the species had been accurately determined in all cases, and thought that possibly there might be more than one species involved.

Mr. Smith was of the opinion that there was but one species engaged in New Jersey, and that this was the very common species. He stated that the imported *Zeuzera pyrina* worked the younger trees in such a way as to weaken them by going around the trunk and girdling it completely under the bark; then the first heavy wind would carry the tree to the ground.

Mr. Felt stated that another species (*Cossus centerensis*) occurred in the vicinity of Albany in poplars, and that its work was quite different from that of the carpenter worm.

Mr. Smith replied that in New Jersey there was another native species which was smaller than the one under discussion; but its habits of boring were different, and the species is quite rare.

Mr. Howard remarked that the Division of Entomology had recently made some examinations, and had found that oaks infested by the oak carpenter worm (*Prionoxystus robiniae*) were noticeably smaller than trees not infested. The same year the insects were all destroyed in the trees found infested by the use of carbon bisulphid injected into the holes. Six months after he had published his paper on shade-tree insects he had been obliged to change his relative rating of oaks on account of this insect.

Mr. Smith remarked that he had used this method against the wood leopard moth in private grounds in the vicinity of Jersey City. The species has now spread to New Brunswick, but he did not regard it as a dangerous insect there. He had been watching it for many years, as it slowly spread from one city to another. The native birds kept it in check outside the sparrow range; but he had found it occasionally in nursery examinations close to cities, and here the insects might be very abundant, there being no native birds to keep them down. He had found the larvæ almost every year, but rarely in an orchard or on fruit trees, except such as were inside of city limits.

Mr. Scott called attention to a rather remarkable occurrence of one of the powder-post beetles which occurred in a dwelling on Washington street, Atlanta, Ga. His attention had been called to it by one of the inmates of the house, who requested him to make an examination. The trouble had existed for a week, and every day it had been necessary to remove the carpets from the floors and sweep up. An investigation of the cellar of the house and the floor above revealed that the timbers were thoroughly riddled by the tunnels of this beetle. He advised that the city building inspector be called, as the house appeared to be dangerous. He sent specimens of the insect's work to Dr. Howard with the request for a remedy. So far as he knew, nothing had

been done and the usual remedies for injury of this character were here of but little use.

Mr. Sanderson stated that he had had some experience in his own house with a small beetle, about one-third of an inch long, the species being unknown to him. He could advise no means of killing it.

Mr. Quaintance asked if there had been any experiments made in fumigating to rid houses and cellars of white ants.

Mr. Marlatt said that it was very probably true that the subterranean colonies of the white ant would not be reached by the gas treatment, but that if the flooring could be loosened and the gas put as near as could be to the infested region, a great deal of benefit might result. The trouble would come, however, from the fact that the white ant colonies had numerous branches, and many of these would be beyond the foundation of the house. With regard to the use of creosote, he stated that for several years past the recommendation of the use of this substance had been made by the Division of Entomology, and that it was mentioned by himself in a recently published circular on the white ant. The use of creosote referred to was more in the nature of forcing it through the body of the timbers, as well as coating and soaking the exterior, and when so done it was believed to be a very effective means of preventing white-ant damage. The chief objection to it was the expense of the treatment.

Mr. Smith related an experience from New Brunswick, N. J. In one of the churches there had been trouble, and, in taking out the old organ, the timbers were found to be riddled by white ants. He had been consulted in the matter, and, in accordance with his suggestions, the worst infested timbers were removed and replaced with iron beams. Where it was necessary to keep wood, this had been soaked in a creosote preparation. Up to the present time he had heard nothing further of the matter.

Mr. Osborn remarked that it is almost necessary to find the nests of these insects to treat them, but did not consider gas would be effective if the insects were locked up in the timber. He was of the opinion that it would be difficult to kill them by fumigating, as the fumes of the gas did not penetrate to any extent.

Mr. Scott stated that he had spent a number of hours in an attempt to locate the nests of white ants, but that they were hard to find. Soaking timbers with creosote, as stated by Dr. Smith, had been used at different times by him in the South, but had not proven to be of much value. He thought that possibly some system of forcing creosote through the wood might be of value. He had frequently suggested that this be done, but the expense of the creosote seemed to be an objection, and he considered it of little value.

Mr. Hopkins called attention to a very excellent report from the Bureau of Plant Industry, by Dr. Herman von Schrenk, on the treatment of timber for fungi and insects.

Mr. Felt called attention to the fact that in New York State, when they had been suffering from drought, the pine trees had been very badly attacked by bark-borers. The fruit-tree bark-beetle had also been causing injury in the last two years. He had wondered what the cause of this was, and it appeared that this outbreak apparently began at the close of two or three excessively dry years. There was an excessive drought in July and August in that section in 1896, and the trees suffered considerably.

Mr. Hopkins stated that he had noticed that it was claimed that much injury had been caused by drought, but that he was a little skeptical as to the effect of drought on large trees. He had examined a number of the spruce trees, some growing on rocks, and others in the lowlands, where there should be an abundance of moisture.

Mr. Burgess asked Mr. Hopkins if the elms in the woodlands had been much attacked by *Saperda tridentata*. In Cincinnati, a great many of the elms had been seriously affected, and they were losing a large number of their trees. He desired to know if the injury had been general or not.

Mr. Hopkins replied that he had not observed this species in the forest elms in West Virginia.

Mr. Smith stated that, in the case of trees that had been infested by the carpenter worm in the south Jersey pines, he thought that fully nine-tenths of the caterpillars were taken out by woodpeckers. In every tree that is less than 6 inches in diameter, the birds can get at the larvæ without trouble.

Mr. Felt, in reply to Mr. Burgess's question, stated that he had observed the work of *Saperda tridentata* somewhat extensively in New York, and found it confined to shade trees, and not to forest trees, and in some places he had noted considerable injury. Trees 12 to 14 inches in diameter were more commonly injured; in his experience the insect was confined to the American elm.

The secretary presented the following names for membership in the association: Mr. Percy B. Gregson, Waghorn, Alberta, Northwest Territory; Mr. H. W. Peal, Indian Museum, Calcutta, both proposed by Dr. Howard; and Prof. Wm. Lochhead, Guelph, Ontario, proposed by Dr. Fletcher. Messrs. Peal and Lochhead, being official entomologists, the secretary was directed to add their names to the list of members. On motion, Mr. Gregson was elected to membership.

Mr. Felt proposed the name of Mr. J. J. Barden, nursery inspector in the State of New York. Mr. Osborn moved that a committee of three on membership be appointed to consider the application of Mr. Barden and others for membership. The chair announced as this committee Messrs. Osborn, Smith, and Felt.

The report of the secretary and treasurer was next read, and on motion of Mr. Howard was adopted.

Mr. Smith thought it well to appoint a committee to propose an amendment to the constitution which would permit the revision of the membership lists, and, after considerable discussion, he moved that the matter be referred to the committee on membership already appointed, which was duly seconded and carried.

The secretary next read letters from members who were unable to be present, but extended their best wishes to the association.

On motion of Mr. Howard, a committee of three was appointed to arrange the programme, as follows: Messrs. Marlatt, Smith, and Quaintance.

It was moved and carried, that committees of three each on nominations and resolutions be appointed by the Chair. The Chair stated that these committees would be announced later. The meeting then adjourned to reassemble at 2 p. m.

AFTERNOON SESSION, FRIDAY, JUNE 27, 1902.

The meeting was called to order by President Hopkins, who announced the first paper on the programme to be by Mr. A. F. Burgess.

NOTES ON THE USE OF THE LIME, SULPHUR, AND SALT AND THE RESIN WASHES IN OHIO.

By A. F. BURGESS, *Columbus, Ohio.*

Owing to the serious difficulty encountered in successfully treating fruit trees infested with San Jose scale, a limited number of experiments were planned by Prof. F. M. Webster to test the efficiency of the lime, sulphur, and salt wash in Ohio. For this purpose young apple trees were selected about 10 to 12 feet in height and badly incrustated with scales. Mr. Wilmon Newell, late assistant entomologist to the Ohio experiment station, prepared the wash and thoroughly sprayed the trees December 31, 1901. The formula used was that recommended in Bulletin No. 3 (n. s.), Division of Entomology, viz, 40 pounds of lime, 20 pounds of sulphur, and 15 pounds of salt, with the addition of enough water to make 60 gallons of wash after these ingredients had been boiled as prescribed.

The rainfall at Wooster for the month of January amounted to only 0.63 inch, and was distributed as follows:

	Inch.
January 3.....	0.02
January 11.....	.05
January 12.....	.05
January 16.....	.02
January 21.....	.40
January 26.....	.05
January 27.....	.02
January 29.....	.02

During the last part of the month snow fell instead of rain, but as it did not adhere to the trees to any great extent, its melting caused little of the wash to be removed.

The climatic conditions were what would be considered favorable for the successful use of this wash.

No careful inspection of the trees was made until May 24, 1902, but previous hasty examinations showed that a large number of the scales were becoming loosened on the trees and were falling to the ground. On the latter date the writer inspected these trees, and was unable to find any living scales whatever, except a few females which were nearly full grown. Ten per cent of the females that had reached this degree of maturity were found to be alive, but on comparing the total number of living scales present on the trees with the number present before the trees were sprayed it appeared that at least 98 per cent had been destroyed.

In Ottawa County the lime, sulphur, and salt wash was prepared by several owners of orchards, and applied to peach trees late in March, 1902, with satisfactory results. In one instance, a heavy storm of hail and rain fell shortly after spraying, and washed considerable of the deposit from one side of the trees. The owner, fearing that the wash would not be effective, resprayed some of the trees on this side, very lightly, with crude oil. On June 14 an occasional live scale could be found, but the treatment appeared satisfactory. On examining some of the trees sprayed at the same time, but which had not been resprayed on one side with crude oil, no perceptible difference was apparent in the number of living scales present.

A single case has been reported on Catawba Island where peach twigs have apparently been injured by this wash. The spray was prepared by the owner, the same formula being used as in the Wooster experiments. A large block of thrifty peach trees was sprayed on March 22 and 26, the weather following being dry and favorable for the effective use of the wash. On examination June 14, the writer found that many of the twigs on some of the trees had died from 4 inches to over a foot from the terminal bud. The foliage below the dead twigs was green and healthy in appearance, but the crop of fruit had been greatly reduced. The greater part of the trees in this orchard, treated in the same manner, showed no injury, hence it is difficult to understand the exact cause of the damage.

The resin wash was also prepared and applied by Mr. Newell to apple trees slightly infested with the San Jose scale. It was made as directed in the bulletin previously mentioned, using 20 pounds of resin, 5 pounds of caustic soda, and $2\frac{1}{2}$ pints of fish oil, and, after boiling for four hours, it was diluted with sufficient water to make 100 gallons. The spraying was done January 8, and the trees were not examined until May 24. At this time only a single living scale was found, although several hundred scales were carefully inspected.

Mr. W. H. Owen sprayed a row of badly infested trees in his peach orchard on Catawba Island with a resin wash, but the formula contained more fish oil than the one above quoted, and caustic potash was substituted for caustic soda.

The trees were sprayed April 15 and 22, and the fruit buds apparently sustained no injury, as a good crop of peaches is growing. It was estimated, after examining the trees June 14, that 98 per cent of the scales had been destroyed.

The results of the limited number of experiments this year indicate that these washes can be used in Ohio with good success, if climatic conditions are favorable, and if the preparation and application is careful and thorough. Whether orchardists will be able to duplicate the results of these tests as satisfactorily on a large scale and under different weather conditions can only be demonstrated in this State by the work of another season.

Basing the cost of materials on quotations received from wholesale firms in Columbus, the lime, sulphur, and salt wash can be prepared for a little over one cent per gallon. The resin wash is considerably cheaper, unless a more concentrated spray is desired. These estimates do not include the cost of preparing the wash, which takes considerable time, and should the materials be bought at retail prices the expense would be increased.

After the conclusion of Mr. Burgess's paper, it was voted to defer discussions until all of the papers on this subject had been presented.

Mr. E. P. Felt then presented the following paper:

EXPERIMENTAL WORK IN NEW YORK STATE AGAINST THE SAN JOSE SCALE.

By E. P. FELT, *Albany, N. Y.*

The apparent complete destruction of the San Jose scale following the spraying operations of the writer last December is in marked contrast to some results obtained in other sections of the State. The work was done December 11, 1901. The day was an ideal one, there being very little or no wind most of the time and the temperature ranging from about 30° F. in the shade to 68° in the sun. The trees were dry, and, despite the fact that there had been considerable cold weather and much snow the previous week, even the very bases of the trunks of the trees were exposed and dry and the insecticides could therefore be applied to the greatest advantage. The sun shone brightly most of the day, and it was one which would be characterized as a drying day. The apple orchard, where most of the work was done, consisted of over 60 young trees, many of which were in an exceed-

ingly bad condition on account of the abundance of the San Jose scale and a number were badly infested by the round-headed apple-tree borer.

A 20-per-cent mechanical emulsion of a light, crude petroleum (41.1° Beaumé), obtained from the Derrick Oil Company, was applied to 22 apple trees and to 14 plum, pear, and quince trees. Examinations this spring, even as late as June 12, showed that the apple trees had apparently suffered little or no injury from the insecticide. These trees are not in good condition this spring, but this is due almost entirely to serious injuries inflicted by the two insects above named. The Clapp's Favorite pear trees were injured somewhat, several limbs being killed, the bark cracking in places and some suckers being thrown out. The Dutchess pear trees suffered less and the Bartlett's apparently escaped without any injury, being in excellent condition and two of them bearing considerable fruit. The tips of a number of limbs on a Globe peach tree were all dead this spring, but this can not be attributed to the insecticide, as some untreated trees suffered in the same manner. The treatment may, however, have facilitated winter killing. Several Meeche's Prolific quince trees were also sprayed, without the slightest deleterious effects being observed.

Good's potash whale-oil soap No. 3, two pounds to the gallon, was applied on the same day to 23 apple trees and 10 pear, plum, cherry, and quince trees. The Clapp's Favorites, Bartlett's, Beurre d'Anjou, and Vermont Beauty pear trees suffered no injury and bear some fruit. A yellow gage plum has no fruit and a Magnum Bonum plum bears considerable. Both trees are in excellent condition and evidently suffered very little or no harm from the insecticide, unless the fruit buds of the first-named variety were killed, which is hardly probable.

Good's tobacco whale-oil soap No. 6, two pounds to the gallon, was also tested under the same conditions on 10 apple trees and 18 green gage plum trees. The apple trees showed very little or no injury, while most of the plum trees have suffered harm, which is shown by the majority developing a considerable number of adventitious shoots.

Two small apple trees were painted with linseed oil, the raw product being used on one and the boiled on the other. The first was killed outright by the application and the second nearly so. This substance is so dangerous that its use in the fall can not be recommended.

All of these applications have, so far as present examinations can determine, given most excellent results so far as insecticidal purposes are concerned. Many of the trees were very badly encrusted with the San Jose scale and apparently not a single scale has survived the treatment. This statement may need modification as the breeding season advances, but the present indications are very satisfactory indeed.

REPORT OF EXPERIMENTS WITH LIME, SALT, AND SULPHUR WASH AGAINST THE SAN JOSE SCALE IN MARYLAND.

By A. L. QUAINANCE, *College Park, Md.*

As a result of experiments by the entomologists of the Division of Entomology, United States Department of Agriculture, and others, it has perhaps been generally accepted that the lime, salt, and sulphur wash, so effective in California against the San Jose scale, is of comparatively little value in the East, owing to our more rainy climate. In the past few years, however, numerous reported cases of its successful use have awakened renewed interest in the wash, and further experiments have seemed desirable, particularly in connection with a record of weather conditions, which seem to be an important factor in the results following its application.

The past winter applications of the lime, salt, and sulphur wash were made in three different localities in Maryland, namely: College Park, Prince George County; Annapolis Junction, Howard County; and Sharpsburg, Washington County.

Experiment I.—At College Park, 20 five-year-old Japan plum trees, badly infested with scale, were treated on March 4. A Pomona barrel sprayer was used, fitted with Seneca nozzles. The wash was made according to the following formula:

Lime	pounds..	40
Salt	do....	15
Sulphur	do....	20
Water	gallons..	60

The sulphur and 20 pounds of quicklime were placed in a barrel with 20 gallons of water and steam cooked for one and one-half hours, after which the salt and the remaining lime were added and the whole cooked for one-half hour longer, after which the balance of the water was added.

At the time of making the application the weather was cloudy, and the temperature ranged somewhat above the freezing point all day. Soon after the work had been finished a light snow began to fall, which alternated with rain and sleet during the night and most of the following day. The trees were wet almost continuously for a period of twenty to twenty-two hours immediately following the application of the wash. Several succeeding days were clear and bright, with the temperature ranging mostly above the freezing point. The precipitation and aspect of sky from March 4 to May 31 is given in the following table, as taken from the weather record book of the United States Weather Bureau, as recorded by Prof. W. T. L. Taliaferro at the experiment station, about one-fourth mile from the treated trees:

Record of weather from March 4, 1902, to May 31, 1902, in connection with lime, salt, and sulphur experiment at College Park, Md.

Date.	Precipitation.	Character of weather.	Date.	Precipitation.	Character of weather.
	<i>Inches.</i>			<i>Inches.</i>	
March 4	1.07		April 26.....	0.31	
5	.41		27.....		Clear.
6-11		Clear.	28.....	.14	
12	.34		29.....	.19	
13	Trace.		30.....		Clear.
14-15		Clear.	May 1.....		Clear.
16	.29		2.....	.41	
17-27		Clear.	3-6.....		Clear.
28	.71		7.....	.09	
29-30	.31		8-10.....		Clear.
31		Cloudy.	11.....		Part cloudy.
April 1		Cloudy.	12.....		Clear.
2-3		Cloudy	13.....	.03	
4	.06		14-17.....		Clear.
5-6	.05		18.....		Part cloudy.
7	1.10		19.....	.33	
8	.40		20.....	.19	
10		Part cloudy.	21-22.....		Clear.
11-13		Clear.	23.....	.64	
14	Trace.		24-25.....	.69	
15		Cloudy.	26.....	.32	
16		Part cloudy.	27.....		Part cloudy.
17		Clear.	28.....	Trace..	
18	Trace.		29-31.....		Clear.
19-25	Trace.	Clear.			

As will be noted in the table, there were 1.48 inches precipitation on the night and succeeding day following the application. There was a light rain of 0.34 inch on March 12, eight days after date of application. A light rain also occurred on the 16th, and 0.71 inch fell on the 28th, with a precipitation of 0.31 inch during the 29th and 30th. There was thus a total precipitation from March 4 to 31 of 3.13 inches. During April rain fell at seven different times, with a total for the month of 2.25 inches. During May rain fell on eight different dates, with a total of 2.70 inches.

Frequent examinations of the treated trees were made to note the effect of the wash on the scales. The earlier examinations indicated that a very large percentage of the scales had been killed. Later examinations, however, showed that these estimates had been placed too high, and in the final examination, on June 2, of many branches and twigs from different trees the percentage of scale killed was placed at from 55 to 60 per cent. At this time the young lice were very abundant, many having settled on the limbs, leaves, and fruit. Scraping the infested branches with a knife revealed the bright, yellow bodies of the mature females in great numbers, and running the blade flat-wise pressed out an abundance of oily fluid from the scales.

On the whole, the treatment was far from satisfactory, and was not sufficiently so to render the use of the wash profitable in comparison with some of the other insecticides used against this species.

Experiment II. The test at Annapolis Junction was made on an orchard of 225 ten-year-old apple trees and about 50 two-year-old peach trees. There was a general sprinkling of the scale throughout the orchard, and many trees were quite badly infested, the trunk and limbs being mostly incrustated with scale. The wash as made up was identical with that used at College Park, but was cooked in a large iron boiler instead of in a barrel by the use of steam. The wash was applied with the same apparatus, and when finished the trees were quite thickly and uniformly coated with the mixture. The treatment was made on March 27 and 28, the weather being clear, with but little wind. The following weather record as furnished me by Col. W. S. Powell, on whose farm the work was conducted, is of interest in this connection:

March 29. Warm, with showers in afternoon.

March 30. Showers in afternoon.

March 31. Snow and rain; cold winds.

April 1. Cold winds.

April 2. Cold winds.

April 3. Fair.

April 4. Light rain.

April 5. Fair.

April 6. Light rain.

April 7. Cloudy.

April 8. Driving rain all day.

April 9. Light rain.

April 10. Fair and cold.

April 12. Fair.

April 13. Fair and windy.

April 14-28. Fair, with variable temperature.

May 6. Fair, with variable temperature.

May 7. Rain during night.

May 8-12. Fair.

May 13. Rain in afternoon.

The weather record was not kept after May 13, as later than this it was not considered as having any bearing on the experiment.

A careful examination of infested twigs from different trees on May 10 led to the conclusion that a considerably higher percentage of scale had been killed than a subsequent examination on June 13 proved to be the case. On this date many young scales were crawling, and very many live scales were exposed by scraping the infested limbs with a knife. After an examination of many trees, both peach and apple, the percentage of dead scale was placed at from 45 to 50.

In considering the weather record for this test, it will be observed that rain fell on the three days succeeding the application, and on

April 8, eleven days after the treatment, there was a driving rain all day. Rain fell in varying amount at eight different times during the course of the thirty days following the application of the wash.

A slight variation was made in the treatment applied to two rows of apple trees, which might here be mentioned. These trees were sprayed with the usual lime, salt, and sulphur wash, to which refined glue had been added at the rate of 3 pounds to the barrel of water. An appreciable difference in the effectiveness of this wash was to be noted, an increased percentage of scale of not less than 18 or 20 per cent having been killed.

In the foregoing tests the results were decidedly disappointing, so far as the effectiveness of the wash was concerned, but considered in connection with the weather conditions which prevailed it is not likely that applications of other insecticides would have given anything like usual results.

Experiment III.—The third test of the wash was made in an orchard of 5-year-old peach trees on the farm of Mr. S. S. Stouffer, Sharpsburg, Md. A block of about 50 trees was selected and treated with the wash on March 22, the day being bright, warm, and calm. Two formulæ were used, the 40-15-20 to 60 gallons of water, and the 30-8-12½ to 50 gallons of water. The rains which occurred, as reported by Mr. Frisby Smith, who also applied the spray, are as follows:

March 28. Light rain.

April 8 and 9. Heavy rain.

May 19. Heavy thunder storms.

May 25. Heavy thunder storms.

The trees in this plat were examined June 19, and the results were quite different from those previously recorded. Live scales were quite hard to find, although some trees were rather badly infested with them. On the whole, the percentage killed was placed at from 98 to 99 per cent. No appreciable difference was to be noted in the results from the different formulæ. The trunks and larger limbs were still coated with the wash, so that the scales were considerably obscured.

The lime, salt, and sulphur wash was used by Mr. Stouffer one year ago this spring on a part of his orchards with gratifying results, and his entire orchard was sprayed with it the present spring. Three years ago the scale was very serious in this orchard, some trees having been killed and many seriously injured. At the present time the insect is under complete control, and no fear is now felt as to the possibility of keeping it in check with this treatment.

SOME PRACTICAL EXPERIMENTS WITH VARIOUS INSECTICIDES FOR THE SAN JOSE SCALE IN GEORGIA."

By W. M. SCOTT, *Atlanta, Ga.*

The Georgia State department of entomology was established in March, 1898, and at that time, as shown by inspections made later, the San Jose scale had become established in 57 counties, including the leading orchard sections of the State. No system of treatment had been adopted, most of the owners of infested orchards not having even determined the cause of the trouble.

In a few instances, however, some knowledge of this pest and its treatment had been gained through correspondence with the Division of Entomology and the Georgia Experiment Station. In the Tifton section some 50,000 peach trees had been subjected to the gas treatment, and whale-oil soap was being used quite extensively in Randolph County, but as a rule practically nothing was being done to control this pest. The gas treatment, although giving good results, proved to be too cumbersome, and the soap washes, owing perhaps to lack of thorough application, were unsatisfactory.

Our State law was such as to compel the treatment of infested orchards, and it was incumbent upon the newly appointed entomologist to furnish the remedy. After some preliminary experiments the oil-water treatment was adopted and a 25 per cent strength of kerosene was recommended for the winter of 1898-99. The results were generally satisfactory, but it was found advisable to reduce the strength to 20 per cent. Experiments with crude petroleum, made the following year, gave this substance the preference, better results being obtained with it than with corresponding strengths of kerosene. For several years, therefore, kerosene and crude oil in mechanical mixture with water have been very extensively used against the San Jose scale in Georgia, and, though on the whole successful, there have been several cases of more or less serious damage to the treated trees. In most cases the damage has been accurately traced to some defect in the pump, carelessness in the application, or other causes within the power of the orchardist to control. But there have been a few cases where the resulting damage could be attributed to no fault of the operator. These adverse results gave rise to some distrust of the oil sprays, which was augmented by the arguments of certain vendors of sure-cure washes and compounds guaranteed to exterminate the scale without damage to the trees.

In order to test these "cure-all" compounds and other better known scale washes in comparison with the oils officially recommended by

^aFor valuable assistance in the execution of these experiments the writer is indebted to Mr. W. F. Fiske, who personally conducted the larger portion of the work with the soaps and caustic washes; and to the owners of the orchards, who furnished the teams and labor.

the Department, a series of extensive experiments was planned, for the execution of which an orchard of 17,000 2-year-old peach trees was secured from Mr. S. H. Rumph, at Marshallville, Ga. In addition a near-by orchard of Mr. F. J. Frederick's, consisting of about 2,000 4-year-old peach trees was used, more particularly as a test of the insecticides upon bloom buds.

The larger orchard was divided into plots of 400 trees each, and these were so arranged that each plot contained five or more varieties of peaches. The orchard was badly infested with the San José scale, less than 10 per cent of the trees being entirely free, and from 10 to 40 trees in each plot being either completely encrusted or nearly so. The orchard became infested from local spread during the first season after planting, and until the experiments were begun in November, 1901, it had received no treatment.

In the Frederick orchard some scales were found on every tree, and about 25 per cent of the trees were quite badly infested.

The following substances were used in the experiments:

Oils:

- Pennsylvania crude, 43° gravity.
- Refined kerosene, 150° flash test.
- Standard Oil Company's fuel oil.
- California distillate.

Soaps:

- Leggett's Anchor brand.
- Leggett's whale-oil soap compound.
- Good's No. 3.
- Good's No. 6, tobacco.
- Turpentine soap.

Caustic washes:

- Limé, sulphur, and salt wash.
- Crude potash.
- Resin wash.
- Carbolic acid emulsion.

It should be explained that during the course of the winter a large number of the scales perish without treatment. The females that have reached maturity and commenced breeding rarely survive the winter. In making up results, therefore, only the immature overwintering individuals were counted.

PETROLEUM OILS.

Owing to delay in obtaining the crude oil no comparative tests were made until January 15, when the work with oils was properly begun. From that date applications were made at various intervals until March 7, at which time the fruit buds were beginning to part their petals. During the first week in December, however, kerosene in soap emulsion was used at strengths of 10, 15, and 20 per cent.

Nearly all sorts of weather conditions were met with, and an excel-

lent opportunity was thus afforded for testing the influence of the weather upon the effect of the oil sprays. Applications were made on fair and cloudy days, immediately before and after rains, early mornings, and late afternoons. Peculiarly enough, however, the different conditions attending the various applications made no apparent difference in the effect of the oil upon the trees or scale insects; likewise no appreciable difference in the results could be detected between early and late applications. This was rather surprising, as it was expected that applications followed within a few hours by clouds and rain would result in damage to the treated trees.

No attempt is made to record the details of these experiments here. Below some of the tests are summarized in a general way. Applications having been made at different seasons and under different weather conditions, a large number of plots were required and many of these could not be included in the tables.

Crude petroleum.—A summary of the applications and results in the Frederick orchard is given in Table I. It is not deemed necessary to give a similar table of the work in the Rumph orchard which, though on a much more extensive scale, does not give results materially different from those contained in this table. It is worthy of note, however, that the trees in the Rumph orchard received no apparent damage from any strength of oil applied, while some injury was noted in the Frederick orchard, attributable in part to defects in the pump and possibly to some extent to the condition of the trees, the Rumph orchard not having yet come into full bearing.

TABLE I.—*Results from applications of crude petroleum.*

Number of trees.	Age.	First application.		Second application.		Date of final examination.	Effect on scale.	Effect on trees.	General notes.
		Date.	Strength and form.	Date.	Strength and form.				
175	4 years..	Jan. 17	15 per cent in mechanical mixture.	.....	.....	Apr. 16	Less than 1.5 per cent alive.	None, or at most very slight.	Cloudy, and trace of rain on following day (Jan. 18).
25	do	do	do	Mar. 7	15 per cent in mechanical mixture.	do	Estimated 2 per cent alive.	None	Mar. 7 fair and bright; slight precipitation on the 8th.
175	do	Jan. 18	20 per cent in mechanical mixture.	.....	.....	.....do	Estimated less than 0.5 per cent living.	8 trees injured, none fatally.	The damage was caused by imperfection in working of pump. All injured trees in these two plots adjacent.
25	do	do	do	Mar. 7	20 per cent in mechanical mixture.	do	do	12 trees more or less injured—some only slightly, none fatally.	
175	do	Jan. 20	15 per cent in mechanical mixture.	.....	.....	.....do	No live scale found.	4 trees injured, 2 severely.	Day fair, followed by 0.75 inch rain at night.
25	do	do	do	Mar. 7	25 per cent in mechanical mixture.	do	Estimated 3 per cent live scale found.	Very slight.	High percentage of living scale due to portion of twig missed by spray.
175	do	Jan. 24	15 per cent in soap emulsion.	.....	.....	Apr. 17	Estimated 7 per cent live scale found.	Very slight, or none at all.	Portions of limbs on 2 trees found not hit by spray.
25	do	do	do	Mar. 7	15 per cent in soap emulsion.	do	Estimated 0.5 per cent live scale.	None	Jan. 24 cloudy, with trace of rain.
175	do	do	20 per cent in soap emulsion.	.....	.....	.....do	Less than 0.5 per cent of live scale.	do	
25	do	do	do	Mar. 7	20 per cent in soap emulsion.	do	No live scale found out of 1,100 counted.	do	
175	do	do	25 per cent in soap emulsion.	.....	.....	.....do	No live scale found out of 450 counted.	do	
25	do	do	do	Mar. 7	25 per cent in soap emulsion.	do	No live scale found out of 500 counted.	do	

Considering the effect upon both the scale insects and the treated trees, the results were slightly in favor of crude oil applied in the form of emulsion with soap at the strength of 20 or 25 per cent. In many cases 25 per cent oil gave no better results than a 20 per cent strength, the latter proving sufficient to destroy all scales with which it came in contact. Moreover, it was found unnecessary to make more than one application, although the second application doubtless killed some insects that were not reached by the first. No apparent damage to the trees or fruit buds could be definitely attributed to the emulsion. Trees that received two applications of a 25 per cent strength showed little or no ill effect.

Equally as good results were obtained from crude oil applied with the mechanical mixing pumps when a uniform discharge could be obtained. The Gould "kero-water" pump with two 20-foot leads of hose was used and, though apparently the best pump of this nature on the market, it can not always be depended upon for a uniform percentage of oil. For some unexplainable reason the discharge of either oil or water may cease at varying intervals; and even if this regularity lasts only for a moment, a tree may be seriously injured or the scale infesting it may escape unharmed. Moreover, owing to the construction of the pump, a slightly greater percentage of oil is usually discharged through one lead of hose than the other; and with nozzles having small apertures (one-twentieth inch Vermorel were used) there is always some separation of the oil and water in the hose and consequent variations in the composition of the spray from one instant to another. However, it should be explained that with constant care and frequent tests excellent results can be obtained by the use of these pumps. In the experiments no great difficulty was encountered and, with the exception of a very few injured trees and lack of effect on the scale in rare cases, the results compare favorably with those obtained from the soap emulsion.

Kerosene.—What has been said of the comparative value of crude oil in mechanical mixture and in soap emulsion applies equally well to kerosene, the latter form of application giving slightly more uniform results in both cases. The results from a portion of the plats treated with kerosene are contained in Table II, which is made from notes on the early applications of emulsion in the Rumph orchard and later applications of the mechanical mixture in the Frederick orchard.

TABLE II.—*Results from applications of kerosene.*

Num- ber of trees.	Age.	First application.		Second application.		Date of final ex- amina- tion.	Effect on scale.	Effect on trees.	General notes.
		Date.	Strength and form.	Date.	Strength and form.				
175	4 years..	Jan. 20	15 per cent in me- chanical mixture.			Apr. 17	Estimated less than 1 per cent living scale.	None...	Day fair, followed by 0.75 inch rain at night.
25	do....	do....	do....	Mar. 7	15 per cent in me- chanical mixture.	do....	Estimated 3 per cent living	do....	The living scale in this plat found on incrusted trees.
175	do....	Jan. 23	20 per cent in me- chanical mixture.			do....	Less than 1 per cent living scale.	do....	
25	do....	do....	do....	Mar. 7	20 per cent in me- chanical mixture.	do....	1 per cent living scale.	do....	All live scale found were on under- side of one limb.
175	do....	do....	25 per cent in me- chanical mixture.			do....	Less than 1 per cent live scale.	do....	
25	do....	do....	do....	Mar. 7	25 per cent in me- chanical mixture.	do....	Less than 1 per cent live scale.	do....	Mar. 7 fair, followed by slight rain on 8th.
100	2 years..	Nov. 30	10 per cent in soap emulsion.			do....	10 per cent live scale	do....	Strength clearly insufficient.
200	do....	do....	do....	Feb. 24	15 per cent in soap emulsion.	1st week in May.	Estimated 3 per cent living scale.	do....	Weather fair on Nov. 30 and the day following.
100	do....	do....	do....	do....	20 per cent in soap emulsion.	do....	0.1 per cent alive	do....	
100	do....	do....	15 per cent in soap emulsion.			do....	3 per cent alive.	do....	
200	do....	do....	do....	Feb. 16	15 per cent in soap emulsion.	do....	3 per cent still living	do....	Feb. 16 very windy, and on that ac- count spraying discontinued.
100	do....	do....	do....	do....	20 per cent in soap emulsion.	do....	Only a few crawling young found.	do....	
100	do....	Dec. 4	20 per cent in soap emulsion.			do....	Less than 1 per cent live scale.	do....	Dec. 4 fair, followed by cloudiness and 0.08 inch rain on 5th.
125	do....	Feb. 17	10 per cent kerosene in emulsion added to a 4 per cent emul- sion of crude car- bolic acid.			do....	15 per cent living scale	do....	Addition of carbolic acid of no avail.

At strengths of 20 and 25 per cent the results, on the whole, were quite satisfactory and such as to warrant one in continuing to recommend the use of kerosene (preferably in soap emulsion) for scale-infested orchards in Georgia, when crude oil can not be conveniently procured. The crude oil is cheaper and in practice appears to be considerably more efficient, owing to the residuum with which the trees remain coated for weeks after the application.

Fuel oil.—This substance was purchased from the Standard Oil Company with the intention of using it cautiously on only a few trees. On February 18, it became necessary to leave the work for a day in charge of the foreman, a white man, who was given explicit instructions for carrying out the experiment with crude oil in mechanical mixture. Through mistake he got hold of the fuel oil and very carefully carried out the scheme of experiments, thinking that he was using the high-grade crude oil. It was applied to about 1,000 trees in the Rumph orchard. Unfortunately the entire lot was used up before the mistake was discovered and no record was made of its specific gravity. It was applied at the rate of 10, 15, and 20 per cent as a first application and at the same strengths as a second application where the high-grade crude oil had been used a month before in corresponding strengths.

The results were quite surprising, in that the trees suffered no apparent damage even where the 20 per cent strength followed as a second application upon the high-grade oil. Some of the treated trees were slightly backward in putting out foliage, but they soon became vigorous and all indication of injury disappeared. The effect upon the scale was as good as that obtained with the high-grade oil. The 20 per cent strength killed more than 99 per cent of the scale and the 15 per cent strength appeared to be equally as effective, while at 10 per cent the vagaries of the pump became apparent in the results.

Distillate emulsion.—Ten gallons of this substance was obtained from California and used as recommended in that State. It was found that a strength of 1 part of the emulsion to 4 parts of water was required for efficient work against the scale. The results from weaker applications were unsatisfactory. The effect upon the treated trees was slightly injurious, but in no case seriously so.

SOAPS.

All the brands of soap mentioned above were tested more or less extensively, and to record the results from each would require too much space here.

The earlier applications (beginning December 2), except in the case of one brand of soda soap, were generally unsuccessful, owing, in part at least, to adverse weather conditions immediately following. The last series of tests (made March 6) were quite satisfactory, less than

1 per cent of live scale remaining on trees treated with a solution containing 2 pounds to each gallon of water. One and one-half pounds to the gallon, though killing much the larger portion of the insects, was notably less effective. Rain within twenty-four hours after treatment seriously interfered with the results, particularly when a potash soap was used. In one case $1\frac{1}{2}$ pounds to the gallon was more effective than 2 pounds to the gallon applied the following day, both applications having been drenched with rain on the third day.

One hundred or more trees were used in each test, and the general effect (aside from that upon the scale) appeared to be more beneficial than otherwise. Some damage to fruit buds, not, however, of a serious nature, resulted from the early December applications. The spring work gave no ill effect.

CAUSTIC WASHES.

Lime, sulphur, and salt.—Three strengths of this wash were used, the standard formula (30 pounds of lime, 20 of sulphur, and 15 of salt) being diluted to 40, 50, and 60 gallons. It was applied at four different dates, February 28, March 3, 6, and 7.

February 28 was a fair day, with a slight breeze from the southwest during the forenoon, freshening into a brisk wind in the afternoon, rendering thorough work difficult. On March 1, 1.33 inches of rain fell, but the temperature (maximum, 58° F.; minimum, 33°) was cold for the season. On March 5, 0.23 inch of rain fell, followed by two fair days and a slight rain (0.02 inch) on the 8th. No more rain fell until March 14, when it commenced and rained through the 16th, during which time the precipitation amounted to 4.75 inches.

The more thorough observations were made during the first week in May, when it was found that the best results were obtained from the applications on March 3 and 6, which killed about 90 per cent of the scale. On the other plots as much as 20 per cent of the scale could be found alive. However, a more hasty examination, made June 4, showed that the insects were still dying and that before the wash should be exhausted the fatality would be much greater than the earlier observations indicated. The scaly covering of such insects as appeared to be alive were in many cases so corroded by the wash as to afford little protection to the insects. Contrary to expectation, the strongest solution gave no better results than those of greater dilution.

It might be said that the results upon the whole were somewhat gratifying and that further tests may prove the lime, sulphur, and salt wash to be a valuable scale remedy for Georgia. In the light of later knowledge it is quite certain that our method of preparation could be improved upon, as it now appears that some of our poor results were probably due in part to insufficient boiling.

Crude caustic potash.—Crude caustic potash in solution was used at strengths of 1, 2, and 3 pounds to 10 gallons of water. The first application (made in the fall) was of the medium strength, with results far from successful, owing perhaps to wet weather immediately following. The second spraying, March 6, gave the following results as shown by examination made May 6:

- 1 pound to 10 gallons, 25 per cent of scale alive.
- 2 pounds to 10 gallons, 3 per cent of scale alive.
- 3 pounds to 10 gallons, less than 1 per cent of scale alive.

No injury to the trees resulted, but the stronger solutions cut the hose very badly. It is clear, then, that potash used strong enough will successfully destroy the scale, but it is quite impractical to use it extensively at the required strength owing to its caustic effect upon both the hose and the operators.

Resin wash—One application prepared according to the standard formula was followed by no good results.

Carbolic acid emulsions.—Three different washes, of unknown composition, but consisting essentially of an emulsion of crude carbolic acid with varying proportions of oils, soap, and other ingredients, were given thorough trials. It was found that less than a 16 per cent strength of any of these washes was practically ineffective, and though 20 and 25 per cent strengths were reasonably effective, the cost would debar their use.

PRACTICAL WORK IN A LARGE ORCHARD.

In addition to the regular experiments, an orchard of 55,000 three-year-old peach and 1,000 plum trees belonging to Mr. W. C. Wright, of Fort Valley, Ga., was treated under the writer's supervision. Mr. Wright was very much alarmed over the condition of his orchard, and he made a special request of the entomologist to assume full control of its treatment.

Beginning August 8, 1901, the orchard was given an inspection row by row, which revealed 1,000 badly infested trees well distributed. From these centers of infestation the scale had spread generally in all directions, leaving only a small percentage of the trees entirely free. Beginning August 20, all the badly infested trees that had been located were sprayed with a 10 per cent strength of kerosene, using a knapsack "kero-water" pump. This checked the breeding of the scale, and was apparently the means of saving a large number of trees that would doubtless have perished before time for winter treatment.

From December 25 to January 2 each badly infested tree and with 15 or 20 adjacent trees were sprayed with a 15 per cent strength of kerosene, using a barrel pump. In this manner the 1,000 trees representing the centers of infestation had received two applications of oil

(10 per cent and 15 per cent, respectively) and about 1,500 trees one application before the general treatment of the orchard commenced.

It was intended that the entire orchard should be treated with crude petroleum, but delay in obtaining this substance necessitated the continuation of the use of kerosene. Taking the trees in regular order, regardless of previous treatment, 17,000 were sprayed with a 20 per cent strength of kerosene between January 3 and 23. The crude oil had then arrived, and from January 25 to February 7 28,000 peach and 1,000 plum trees were sprayed with a 20 per cent strength of this substance, which registered $43\frac{1}{2}$ gravity on the Beaumé oil scale. The remaining 10,000 trees being detached from the main orchard and containing only a slight infestation of scale, were not taken into account in making notes. However, they were sprayed with a 20 per cent strength of kerosene, beginning February 11. The effect of the treatment was carefully watched, and at the end of three weeks after 20 per cent kerosene had been applied to the block of 1,700 trees in the general treatment, a small percentage of live scale insects could here be found. It was then too early to make a definite determination of the results, but the owner was not satisfied with the indications and the writer consented to another application to this block, advising 15 per cent kerosene, which was applied late in February.

Reviewing the treatment, a portion of the 1,000 badly infested trees was sprayed four times at different periods with kerosene at 10, 15, 20, and 15 per cent strengths, respectively, and the remainder three times with 10 and 15 per cent strengths of kerosene, respectively, followed by a 20 per cent strength of crude oil. A portion of the 15,000 trees that received 15 per cent kerosene before the general treatment commenced was sprayed with 20 per cent kerosene in January, followed by an application of 15 per cent kerosene late in February, while the other portion received a 20 per cent strength of crude oil. Then a portion of the trees that remained unsprayed when the general treatment commenced received a 20 per cent strength of kerosene, followed by a 15 per cent strength, while the other portion received a 20 per cent strength of crude oil only.

The entire work throughout the season was done in the most careful manner possible on a large scale. Six Gould barrel "kero-water" pumps were used, and these were supplied with oil by extra teams while the water was piped into the orchard. The work was done with negro labor, superintended by the owner of the orchard and two intelligent white men, who at short intervals tested the percentage of oil discharged and saw that every portion of the tree was moistened with the spray. When any part of the tree was found dry it was resprayed, even at the cost of turning the team. By the employment of a mechanic the pumps were kept so adjusted as to do satisfactory work.

The results were beyond expectation. When the winter work was

begun the new double-hose arrangement by which the oil and water are kept separate until the nozzle is reached was employed. Instead of producing a mechanical mixture, pure oil and pure water were alternately discharged. On one morning in trying to start five pumps with these attachments a number of trees were sprayed with pure kerosene, resulting in the death of 40. The new style attachment was discarded, and no more injury was done save possibly the death of about 50 other trees which may be attributed to the combined effect of the scale and the treatment. The trees bloomed and leaved out normally, and are now bearing a magnificent crop of fruit.

The scale was as nearly eradicated as the writer believes possible with any treatment. During the course of spring and summer until June 17, when the last observations were made, the writer visited the orchard three times and carefully examined several hundred trees both in the kerosene and crude oil blocks, and found only two trees bearing live scales. These were located in one of the kerosene blocks where two applications had been made. A general inspection of the orchard on June 17 revealed no further infestation of living scales. It is understood, of course, that should every tree in the orchard be carefully examined a large number would no doubt show some living scales, but the observations have been sufficiently extensive to warrant the statement that better results can rarely be obtained with any practical treatment.

SOLUBLE ARSENIC IN ARSENICAL INSECTICIDES.

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The two insecticides to which I chiefly desire to call attention are Paris green and London purple. As is well known, Paris green is composed of copper oxid, acetic acid, and arsenious oxid, which are all combined to form copper-aceto-arsenite, in the following proportions:

	Per cent.
Copper oxid	31.29
Arsenious oxid.....	58.65
Acetic acid	10.06

Since this is a commercial article, small amounts of foreign matter are always present. Among these may be mentioned sodium sulphate, sand, and arsenious oxid, the last of which is not combined as it should be with the other two constituents, but is present in the free state. It is this arsenic which is generally supposed to scorch foliage when applied in too large amounts.

In California, and in the East generally, 4 per cent free arsenious oxid has been adopted as being the maximum amount allowable in Paris

green, the free arsenic being determined by dissolving it from the Paris green by means of distilled water.

What I desire to call attention to here is that there may be three conditions giving rise to a scorching of the foliage by the use of Paris green:

(1) As I have already said, there may be a certain amount of arsenious oxid in the Paris green over and above that combined with the other constituents. This is called "free" arsenious oxid, and has until recently been considered as the only cause for the scorching of foliage by Paris green.

(2) A number of Paris greens now on the market are poorly made, and when brought in contact with water, especially water charged with carbon dioxid, readily break up in the course of a short time, arsenious oxid being set free in the process. This is true to some extent even of the best Paris greens, but the poorly made ones break up much more quickly and readily. Let us see, then, what the effect of such greens would be upon the foliage. They would, in most cases, be sprayed upon the leaves while suspended in water. The water, along with the carbon dioxid of the air, would immediately commence to set arsenious oxid free. Not only would this go on with the original water, but the rain and dew that collect upon the plant would carry the process still further, and in the case of a poorly made article there would soon be enough free arsenious oxid to seriously scorch the foliage. Of course this change would go on in the case of well-made Paris greens, but so slowly that unless the climatic conditions were very adverse not enough arsenious oxid would be present at any one time to do any serious damage.

(3) It is a well-known fact that even the best Paris greens, when ground to a very fine powder and applied to the foliage, will scorch. This seems to be due to the fact that the fine grinding exposes more surface to the action of water (and water charged with carbon dioxid), and that consequently the decomposing action of the water on the Paris green is accelerated and enough free arsenious oxid soon gathers to do serious damage.

It appears, then, that there are three conditions of Paris green that may give rise to free arsenious oxid and consequent scorching, and what confronts the chemist is the discovery of a method or methods by which he can tell how much free arsenious oxid is actually present in a sample of Paris green, or how much, because of its condition, may be set free in a short length of time.

This is rather a hard problem and, from the nature of the case, only an arbitrary method can now be proposed or expected.

Manifestly it would not do to extract the sample for twenty-four hours with water since, in this length of time, even where free arsenious oxid is present as such, it does not all go into solution nor does

a badly made or very fine Paris green decompose to a great extent in this length of time. It has been found by the author that it takes nearly ten days for all free arsenious oxid in Paris green to go into solution. It has also been found that badly made Paris greens are broken up enough during the course of ten days to show whether they are very unstable or not and that well-made Paris greens are not broken to a great extent in this length of time. Avery and Beans^a have found that at the end of ten days a finely powdered article has been broken up to a great extent. It has therefore been thought best to determine the soluble arsenious oxid in Paris green by extracting 1 part with 1,000 parts of water (free from carbon dioxid) for ten days and at the end of this time determine the arsenious oxid in an aliquot portion of the filtrate. This method does not distinguish between the three causes of the soluble arsenious oxid, but it is undoubtedly true that all three are bad, although very likely not equally so. Other work done by Avery and Beans distinguishes to a certain extent between free arsenious oxid as such and the other two forms, so that at least we can say whether the soluble arsenious oxid is due to free arsenious oxid on the one hand or badly made or fine Paris greens on the other.

Since these three distinct types of soluble arsenious oxid have not been previously recognized, and since, when 4 per cent was adopted as the maximum limit of soluble arsenious oxid allowable in Paris green, a much shorter time of extraction with water was used than ten days (resulting in much lower figures for soluble arsenious oxid), it appears to the author that work along this line is needed badly, work that will determine the maximum percentage of soluble arsenious oxid that can be present in Paris green without scorching in each of the three forms, or as many of these forms as our present chemical methods will enable us to recognize.

The Bureau of Chemistry, U. S. Department of Agriculture, in collaboration with the Division of Entomology, is now carrying on preliminary work of this character, but in order to make the work a success each of the States will have to take it up, it being well known that climatic conditions markedly influence the amount of free arsenious oxid that a plant can stand. I therefore lay this matter before you with the hope that entomologists from the various States may be interested enough in the work to collaborate with us during the coming spring. The Department will prepare all samples and send them out and the various entomologists will do the spraying, for which full credit will be given in each case.

The second class of insecticides to which your attention is directed are the London purples. These are prepared by boiling an aniline dye residue containing arsenic with lime. Up to a very recent date

^aJour. Amer. Chem. Soc., Vol. XXIII, No. 2.

London purple was supposed to consist of an organic dye residue and calcium arsenite, but work which the author has carried on shows that it consists of an organic dye residue, calcium arsenite, and calcium arsenate.

While the relative quantities of the two last-mentioned substances vary a great deal, the total amount of metallic arsenic is nearly the same in all samples examined.

According to the old way of examining London purple, a portion was extracted with water and the soluble arsenious oxid determined in the solution. Where this was low the sample was passed as good and was used in spraying. Since it has been found, however, that arsenic oxid is also present, this must also be determined in the soluble portion. Proceeding in this way, it was found that whenever the soluble arsenious oxid was low the soluble arsenic oxid was high, and vice versa, so that in every sample examined the total amount of arsenic going into solution was very high, much higher, in fact, than the maximum limit of 4 per cent that has been previously recognized. Following are examples of three representative samples:

	Soluble arsenious oxid.	Soluble arsenic oxid.
	<i>Per cent.</i>	<i>Per cent.</i>
1	2.43	15.81
2	13.49	7.12
3	1.44	19.56

It is a well-known fact that although London purple has gone out of use to a great extent now because of its scorching the foliage, it has been used and is used in many cases with excellent results. The only conclusion we can come to from the above facts is that many plants, under certain conditions at any rate, can stand a vast amount more of soluble arsenic than has been previously supposed. Of course, if this arsenic were present as the free acid it would undoubtedly kill or defoliate the tree; but its being present, as it is in London purple, as the calcium salts of arsenious and arsenic oxid evidently has a strong modifying influence.

Compounds of this class are also being studied by the Bureau of Chemistry and Division of Entomology and, just as in the case of Paris green, the cooperation of the various States is absolutely indispensable to the success of the work.

The foregoing paper by Mr. Hayward was read by the secretary of the association.

After the reading of these papers, they were opened for discussion.

Mr. Smith stated that he had taken a greater interest in these

papers than in any series of papers for a long time. He thought that they covered a field that had not been satisfactorily covered before. It happened that when the lime, sulphur, and salt wash was first tried in Washington, the result as recorded by Mr. Marlatt and others was that it afforded but little protection. One or two others tried the same material and the results were equally poor. In a second bulletin from the U. S. Department of Agriculture, the chemical reactions in the wash were set forth and it was shown almost conclusively that it could not reasonably be expected to be of much value in the moist East. A year or two ago one or two Jerseymen tried the wash on rather badly infested peach orchards, and the results seemed to be very good. During the past winter a number of other New Jersey fruit growers had successfully tried the wash. He called attention to a point not previously mentioned, namely, that the results of recent experiments in Illinois had been remarkably successful. He thought that the experiment there was nearly a complete success, 99 per cent of the scale having been killed at the time when Dr. Forbes's bulletin had been sent to the press. Dr. Forbes examined the experiment trees before the wash was applied, and discovered that when the winter had set in fully 50 per cent of the scale was dead. This fact was to be considered in estimating the amount of good done by washes. He had seen trees where no treatment had been made where 75 per cent of the scale was dead in the early spring. Any sort of wash put on during the winter, if no previous count had been made, would be credited with killing 75 to 80 per cent of the scale, so that there will be an element of error in the statement of results unless previous examination has been made. This is a point to which Dr. Forbes gave proper attention. He was the first one, who in his records of results, took pains to take this into consideration and published the count. Mr. Smith stated that there are a number of localities in New Jersey where the lime, sulphur, and salt wash has been used on peach, pear, and apple. Very few plums had been treated and more peach than any other fruit. One of these places is in the vicinity of Mount Holly; a second is nearer to Camden; the third is in the vicinity of Heightstown. They were all in one general section of the State, and something like 70,000 or 80,000 trees were treated on a commercial scale. The formula used was almost universally 50-50-50 to 150 gallons of water. The proportion of the sulphur to the water was nearly the same in all of the mixtures. The preparation was very thorough, some steaming and some boiling direct. He had visited almost every one of the sprayed orchards, and the last visit had been only two or three days ago. The majority of the trees were large. The work was done with barrel sprayers or with power sprayers on carts. Where the work was done on small trees that were not badly infested the results were very good. A great many trees seemed to

have few or no living scale on them. In one orchard, although the breeding season was already well advanced, there was only a single tree upon which any larvæ were found, but there were quite a number of trees where living females occurred. The adjoining orchards showed that the scale was in full progress of breeding. Wherever very badly infested orchards were found it was observed that the wash had been least effective; that is, it was not successful in killing any large percentage of the scales. A tree incrustated with scales, still coated with the spray, would, on examination, be found to contain great numbers of the living insects underneath. So where the material was most needed it was least effective. On adjacent trees on which the scales were scattering the effect of the wash was very good. The wash does not penetrate nearly as well as the oil or soap mixture, and it does not spread at all. Where it hits it sticks and seems effective, but it does not have much penetrating power. It is, furthermore, difficult to get it on the smaller twigs. This is an important point with apple trees, and unless the twig is hit the insects will not be killed. Farmers generally agree that it takes 3 gallons of the lime-sulphur-salt wash to do the work of 1 gallon of oil mixture. In New Jersey a gallon of the wash was stated to cost for material about $1\frac{1}{2}$ cents. This did not include the cost of mixing and the incidental cost of boiling and time of the laborer. In practice a sufficient amount of the wash to go as far as 1 gallon of oil would cost $4\frac{1}{2}$ cents. One orchardist used both, and prefers the oil because of its convenience. The farmers in New Jersey used the undiluted oil more than the emulsion. Some had tried to make a soap emulsion, but had lost all interest in the mixture. He thought there was no doubt that, particularly in peach orchards, the lime-sulphur-salt wash could be satisfactorily used. The oil was hard on peach trees, unless sprayed on with a very fine nozzle, and very carefully.

Mr. Marlatt said that he desired to join Dr. Smith in his hearty appreciation of the value of the papers presented. The experiments and work reported were of great interest on account of their considerable extent. He believed that the results of the work reported by Professor Scott and others in the South indicate that the question of how to practically control the San Jose scale has been solved. He congratulated the authors of the papers very heartily on the results obtained by them. He referred, in brief, to his personal experience with the use of oil on trees, including the orange in California.

In reference to the early experiments of the Department in the East with the lime, sulphur, and salt wash, he stated that the work was conducted by Mr. Coquillett and himself, and was carried out in the most practical way, Mr. Coquillett having recently come from California, and being thoroughly familiar with methods there employed. A careful record of weather conditions was kept subsequent to the treat-

ment. The percentage of scales killed was noted from time to time throughout the winter and the following spring, and in the case of no tree, even where the wash had been used at considerably greater strength than recommended in California, were results of any very great value seen. A full record of these experiments is given in Bulletin No. 3 (new series) of the Division of Entomology. It was noted at the time of these tests that a considerable percentage of the San Jose scale died during the winter where no treatment had been given, usually as much as 40 or 50 per cent perishing. Therefore, the treatment was considered to be of no value unless a notably greater percentage of scales were killed than would have succumbed normally. Both the California wash and the Oregon wash were tested at normal and double strengths. With the knowledge that the applications, as reported above, were more carefully made than would be ordinarily the case with farmers and fruit growers, the results were so poor that this wash was not recommended for use in the East. The reports of the success following its use in California, in view of these results, were not easily understood, and at first it was thought they might be founded on error, but the speaker had subsequently the opportunity to visit California and personally inspect results on the Pacific slope, and he found that there was no possibility of questioning the efficiency of the wash in that region. The explanation was evidently in the differences in climate between the Atlantic and Pacific coasts. In the former, the wash being applied in winter, remained on the trees unaffected by rains or moist weather, often for several months, the wash being applied after the rainy season, in late winter. In the East, on the other hand, the wash is usually subjected to washing rains within a few days after application, and it was believed that this explained the difference in results. Later on he had again taken up the investigation of the lime, sulphur, and salt wash in cooperation with the Bureau of Chemistry of the Department of Agriculture. The results of these experiments are given in Bulletin No. 31 (new series) of the Division of Entomology. The wash had been prepared with the use of a steam plant and after the most approved California methods, and was applied almost boiling hot to scale-infested trees. In this instance it killed every scale on the trees, the application being thoroughly effective. The reason for this seemed to be that the weather conditions following the experiment were very favorable. The heat of the wash does not explain the death of the scales because, however hot may be the liquid when broken up into a thin spray, it is cool a few inches distant from the nozzle. Mr. Marlatt further stated that he still believed that, as a rule, the same difference would be experienced between the East and West on account of the greater rainfall of the former section, and that the wash was on this footing, namely, that if weather conditions are

favorable it will be efficient; otherwise measurably useless. The cost of the application is very slight, especially if it is prepared in hogsheads with steam. He said that the surprising results reached by Dr. Forbes were difficult of explanation, especially as rains or artificial washing of sprayed plants did not seem to affect the efficiency in the case of his tests. He believed that the result of Dr. Forbes's work made it necessary for experiment station entomologists everywhere to give the matter again a thorough test in the East, and he proposed that the Division of Entomology in Washington undertake experiments next winter with the wash. The chemical analyses which had been made by the Bureau of Chemistry indicated that while the wash would remain in evidence as a white coating on the trees for a long time in spite of heavy rains, most of the beneficial elements would soon be leached out. As to the formula for the wash, he stated that it varied with almost every person who experimented with it. The chemical reaction between the sulphur and lime was well known, and if too much lime was used, as was ordinarily the case, it simply remained free lime in the mixture and added to the coating on the trees. The general reactions with the lime, sulphur, and salt were noted in the chemist's report in the publication cited above.

Referring to the records of percentage of scales killed, he said that in making these estimates it was necessary to take into account the transformations of the scale insects, and that the great majority of the San Jose scales on a tree in late winter would be the male scales. On trees in the orchard in the Department of Agriculture, perhaps 97 per cent of the living scales on the trees in April of this year were of the male sex. These hatch out very early in the spring, and when they are gone at once give the appearance of death to a very large percentage of the scales on the trees. He stated also that, where female scales from any cause have not been fertilized by males, their period of life is very greatly increased, so that it is sometimes possible to find overwintered female scales on trees in midsummer. An examination he had made of some of these had indicated that they had not been fertilized and were not developing eggs, and they ultimately perished without having reproduced. It thus might happen that all the male scales would be killed, and the female scales would remain unfertilized, though alive, and would perish before a succeeding brood of males would be produced.

In California the difficulty of spraying large trees was largely reduced by having them pruned back vigorously, and it was generally believed that the benefit in the case of gathering the fruit and the superior quality of the fruit coming from this vigorous pruning offset the cost and trouble of spraying, so that the San Jose scale instead of causing a loss had really worked advantageously to the fruit grower. This applied especially to the peach and prune.

Mr. Marlatt added that Dr. Forbes's experiments had had special relation to the subsequent action of washing rains, and that they seemed to show that such rains had no effect on the benefit coming from the wash. Furthermore, Dr. Forbes had actually thoroughly washed with water trees which had been treated, and again the action of the insecticide had not been decreased. It was on this account that Professor Forbes's experiments were of so great importance and opened the whole subject for renewed investigation, indicating, as they seemed to do, that the wash could be used in regions where rains are frequent as well as in dry climates like those of the Pacific coast.

Mr. Smith suggested that perhaps a large number of small trees had been used in the experiment.

Mr. Felt in this connection called the attention of the association to the influence of rains on the wash in New York State and considered it to be apparently what would be expected. He had examined some treated limbs and found the live female scales quite abundant. He was informed that the application had been followed by quite a little rain, and in his own experiments he was in hopes that some would fall, and the rain came immediately after, thus furnishing him exactly what he desired. The entire experimental orchard was sprayed, and it seemed very doubtful if the work could be completed before the rain came, but the work was finally finished. The rain continued for about three days, so that he considered it a very severe test. The treated trees were looked over at different intervals until about ten days ago, and of the trees treated with the wash some at least contained living female scales, although most of them were not very badly infested. The most of the living insects were, as Dr. Smith had stated, under masses of scales. The wash did not penetrate into the masses, and it was his experience that where the bark was rough the insects were not seriously affected. He thought that when the wash was applied the trees should be dry.

Mr. Smith, in reply to a question, said that one of the farmers whom he had advised to use the kerosene emulsion had used 5 pounds of soap instead of one-half pound, as ordinarily recommended. The resulting mixture was very satisfactory, but it was a fatal one. The emulsion was diluted 10 times and applied to the trees just as the leaves were dropping, and the results were very disastrous.

Mr. Scott stated that in his paper he had not included his experiments with summer washes. He explained in regard to crude oil in soap emulsions that as low as 10 per cent of oil very badly damaged trees in foliage, whereas the 10 per cent in mechanical mixture did very little damage; he had found wherever the soap was used in crude oil or kerosene the results were more disastrous than in case of the mechanical mixture. Experiments had been made last winter where soap had been used in connection with the oils to determine whether

or not an excess of soap would have any beneficial effects in the kerosene and petroleum emulsions. The soap was used according to the regular formula and from that up to as high as 2 pounds of soap to the gallon of water, so that there was a large excess of soap. The results were not any better than those where the usual amount had been used. In fact, any amount of soap in excess of that necessary to make a proper emulsion he had found valueless. On the other hand, in the summer tests the soap in the emulsions was more injurious than the oils. He stated that he had found quite 40 per cent of scale dying during winter without any treatment, and he took this fact into consideration in making up the results. Frequent communications had been received from orchardists saying that the cold weather had killed the scale. Mr. Scott considered that careful estimates should be made of the scales that die without treatment in determining the percentage killed by the application of washes.

Mr. Quaintance asked if anyone had had any experience with the lime, salt, and sulphur wash in the fall, and how early it had been used. In Maryland the fall weather is usually more favorable for spraying work than the spring.

Mr. Sanderson remarked that while he had done no work with the wash himself, several orchardists of Delaware had used it, made up according to the standard formula. He had examined a badly infested orchard about ten days ago that had been thoroughly treated with the wash, and the trees at that time were still quite thoroughly coated. A careful examination of infested twigs showed that from 50 to 75 per cent of the adult females were alive. He had had slight experience in the use of crude oil on trees in foliage. Fifteen or 20 plum trees had been sprayed thoroughly, covering the leaves, but no damage had resulted, and the scales had been very largely killed.

Mr. Quaintance desired to know of Mr. Sanderson what the weather conditions were in connection with the use of the lime, salt, and sulphur wash in Delaware, to which Mr. Sanderson replied that he had no record of this. It was his experience that the scale was more readily killed in the Southern sections than in Northern sections. He had tried kerosene emulsion of the ordinary strength, diluted 10 times, and had noted very little change in results from its use.

Mr. Marlatt remarked, in reference to Mr. Scott's experience with emulsion, that the emulsion is often more dangerous to trees than pure oil—that is, if it is put on in a very strong mixture—for the reason that a thick emulsion wash adheres to the bark, and much more oil is held on a given area with the emulsion than would be in a thin pure-oil spray.

Mr. Smith stated that in the soap emulsion the oil is held longer in contact with the trees. The soap holds the oil, prevents its evaporation, and it is thus held longer in position than when put on pure.

He had found that pure oil could be used with greater safety than the soap emulsion.

Mr. Scott called attention to what had been said in regard to the scale being more readily killed in the South than in Northern latitudes and thought this must be correct, because Professor Lowe had recorded in his bulletin that he used a strength of 40 per cent crude oil, the highest ever used, but it was effective against the scale, and that 25 per cent was absolutely worthless.

Mr. Felt replied that in the vicinity of Albany Mr. Lowe's results did not hold good, and that 25 per cent would kill the scales if they were hit.

Mr. Scott stated that 25 per cent crude oil in Georgia would practically kill every scale with which it came in contact. It had been thoroughly demonstrated with two or three years' experience that 20 per cent is all that is necessary. Even 15 per cent crude oil gave good results against the scale and he did not consider it safe to use more than 25 per cent. He was glad that Mr. Marlatt had said what he did concerning the extensiveness of his experiments, as he rather feared that he might be criticised for using such a large number of trees. The Department furnished the oil and the owner furnished the labor, trees, and risk. He stated that there was one orchard in Georgia of 150,000 trees that had been sprayed with the crude oil last winter and another of 200,000, and that, unless one were pretty sure of results, it was too risky to make recommendations. Mr. Scott further stated, in response to an inquiry from Mr. Marlatt, that the crude oil in mechanical mixture was his preference of the different lines of treatment, provided that pumps could be had that would accurately discharge the proper amount of oil. Otherwise the soap emulsion is preferable.

Mr. Smith inquired if the pumps used were of the new model, to which Mr. Scott replied that they were of the latest model, that they had been used one day with the oil and water kept separate, but that it became necessary to discard these connections and change to the old style of pump. His reason for preferring the emulsion was because it could be depended upon almost absolutely, while with the mechanical mixture the pumps gave varying results. One lead of the hose might be discharging a greater percentage of oil than the other.

Mr. Scott further stated that he had used the pure crude petroleum in an experimental way the winter before. Twelve trees had been sprayed, of which number 6 were killed. He considered pure crude petroleum quite unsafe, but thought that it could be used as high as 50 per cent if applied very carefully and very lightly.

Mr. Burgess stated that from the previous discussion it appeared that it must be much more difficult to kill the scale North than farther South. In northern Ohio it was a very difficult matter to kill the scale with-

out injuring the trees. He made some tests with the kero-water pump which were not very satisfactory—that is, the pump would not throw a given percentage constantly—and in the experiments made recently a motor-spray pump had been used. This pump was used largely in the northern section of Ohio and very few trees were injured, but the scale was not held in check. This year the trees were sprayed more thoroughly. Some were over sprayed, and, as a result, at the present time, he estimated that there were probably 10,000 dead trees in that section. This is the principal fruit-growing district, and such a loss means considerable to the growers. The men who applied the spray in this section were growers who have had a great deal of experience in spraying, and certainly would be as careful as hired men. Mr. Burgess related one instance where peach trees were seriously injured by using 25 per cent mechanical mixture of crude petroleum, and called attention to a recent New York bulletin, in which it was stated, from results there indicated, that peach trees sprayed late in the spring were less liable to injury than if sprayed earlier in the season. His experience in northern Ohio was almost opposite. The trees sprayed late in the spring had been injured more than those sprayed earlier, as in January or somewhat later. The fact that so many trees had been killed and injured this year made the scale problem a serious one. The growers were enthusiastic in using the crude petroleum and thought they had found a substance which could be used safely to kill the scale. It seems now that much more care will have to be used in its application, or a safer remedy devised. A good many growers last year thought they had not sprayed sufficiently and this year attempted to spray the trees more thoroughly. On peach trees, a very careful application of crude oil must be made. Attention was called to another point in this connection—that the effect of spraying was different in different years. Some growers had sprayed thoroughly last year and no injury had resulted to their trees. The same trees had been sprayed this year with considerable injury. The results did not seem to show, one year with another, what results might be expected after spraying.

Mr. Quintance remarked that according to his experience in Maryland there was considerable variation in the effect of both kerosene and crude petroleum in different parts of the State. In western Maryland the kerosene treatment, on the whole, had been found quite satisfactory, and 20 per cent kerosene in mechanical mixture was very largely used. On the Eastern Shore, however, the use of kerosene or crude petroleum, even under the most favorable weather conditions, had been reported in numerous cases as giving fatal results to the trees. On the whole, for this territory he was inclined to recommend the use of whale-oil soap. He stated that he had met with much difficulty in the use of the kero-water pump, from the fact that the percentage of

oil varied with nearly every pump, and even the same pump at different times. Many of the orchards in the State were managed by tenants. Under such conditions it was difficult to get the intelligent cooperation necessary to secure proper results from the use of kerosene or crude petroleum.

Mr. Smith suggested that we have to do with a problem for a plant physiologist. The records given were so contradictory that it seemed to him to be due somewhat to the condition of the plant. He suggested that the matter be investigated from this point of view and that it be referred to some plant physiologist. He considered that the experiments reported proved two or three points fairly well—that the oil would kill the insect under the scale if it comes in contact with it, and that a quantity of oil sufficient to touch the insect is all that is necessary. The question of its effect on the tree is an important one. It is not fair to take the results from one part of the country and make them the basis for recommendations for another part. The results which he had obtained in New Jersey had been duplicated time and again in his State. He had never yet succeeded in killing a peach tree with crude petroleum, but had crippled some. He knew of other persons who had killed trees. He did not understand this difference, nor why the scale is more hardy in the North than in the South.

Mr. Holland stated that crude petroleum, as generally supplied, was a most puzzling mixture. He had at the university something like 150 samples of oil ranging from white to some of high specific gravity, and thought that a chemical analysis would probably eliminate some of the trouble. He stated that he considered Professor Phillips probably best qualified to make an analysis of crude oil, and thought the work one of the most complicated problems in chemistry. He thought that if the fruit growers could get the run of certain wells the difficulty might be largely obviated.

Mr. Felt remarked that he had gotten very good results from wells in certain sections, but he was very much puzzled how such contradictory results could have been secured from New York State. The results published by Professor Lowe were not at all like those which he had obtained.

Mr. Burgess agreed that the assistance of a chemist and a plant physiologist were urgently needed.

Mr. Smith stated that the question of determining the composition of crude petroleum and of getting an oil of as uniform a grade as possible for spray purposes was recognized by him as a serious one. At his suggestion the Standard Oil Company, from which he had been securing material, had applied the term "insecticide oil" to a particular grade which they sent out under that name. Oil simply ordered as insecticide oil was of this grade, and had been very uniform, so far as he knew. This oil was and had been used in New Jersey with con-

siderable safety. He fully realized the value of the point that Dr. Holland made; he had tried to get some one to make the analysis; but no chemist seemed to want to touch the problem.

Mr. Hopkins mentioned the fact that the subject of vaseline had been under investigation by the chemists of the West Virginia station. They had taken vaseline and mixed it with kerosene, and experiments had been carried on with it. He thought Mr. Rumsey might be able to give something of interest about this work.

Mr. Rumsey replied that he considered it premature to make any statements concerning this work, as it had not been in progress very long and he had made but two inspections of the trees since the application of the oil.

Mr. Quaintance stated that in his opinion the entomologists would have to ask for help in connection with determining the cause of the variation in results from the use of oils in various parts of the eastern United States as a treatment for the San Jose scale. He considered it a very important matter and thought that the question should be straightened out and put on a scientific basis. Until this was done, the danger of injury to trees sprayed with the mineral oils would probably not be removed. He suggested that the Secretary of Agriculture be petitioned to detail an entomologist, a plant physiologist, and a chemist to make the investigation of this problem a leading line of work.

Mr. Scott stated that he had asked for prices of the Standard Oil Company on their insecticide oil, and their price, with freight added, would make it cost something like 15 or 16 cents per gallon delivered in Georgia. He had corresponded with several oil companies and found that a high-grade oil could be bought and delivered at Savannah for 8½ cents in carload lots. He had first obtained a barrel of the oil and tested it and found it averaged about 43½ Baumé. It had never run under 43 in any of the barrels that were tested. Twenty thousand gallons had been secured for last winter's work. One company proposed to put up crude-oil tanks in orchard sections of the State and supply the crude oil to the orchardist in the same manner kerosene is supplied to the merchants. He asked Dr. Smith what was the specific gravity of the oil that had been used in New Jersey.

Mr. Smith replied that this usually ran between 43° and 44°, but never ran under 43 in any of the samples which he had seen. In every section where crude oil is used, the commissioner has a hydrometer and tests the oil, so that it is thus possible to keep pretty close record of the oils in use in the State.

Mr. Sanderson suggested that the committee on resolutions take up the matter of petitioning the Secretary of Agriculture to detail investigators from the Department to help solve the problem.

Mr. Hopkins suggested that best results were likely to come from cooperative experiments.

The society then adjourned to reassemble at 10 o'clock Saturday morning.

MORNING SESSION, SATURDAY, JUNE 28, 1902.

After calling the meeting to order, the president announced that first on the programme were three papers by Mr. Marlatt:

RÉSUMÉ OF THE SEARCH FOR THE NATIVE HOME OF THE SAN JOSE SCALE IN JAPAN AND CHINA.

By C. L. MARLATT, *Washington, D. C.*

A preliminary report was read before the last meeting of this Association detailing the results of a three months' ^a investigation by the writer of the San Jose scale in central and southern Japan. The present report relates to the investigations in Japan subsequent to July 1, 1901, and the explorations in the autumn of the same year in China. This report is merely a brief summary and is preliminary to an extended account of the trip which will appear elsewhere.

In the discussion which followed the reading by Dr. Howard of the writer's preliminary paper in Denver last year, a misapprehension as to the extent and thoroughness of the investigation was evident on the part of several speakers who seemed to feel that the work had been done chiefly along the railroads, and that, therefore, the interior of Japan was not being explored; and further, that this interior region, if carefully investigated, might throw an entirely different light on the subject and perhaps would demonstrate that the interior and the more inaccessible regions of Japan were the ones from which the San Jose scale had come and in which it is native. Some of the speakers, notably Dr. Howard, felt sure that no opportunities for investigation or localities would be neglected by the writer, but several of the speakers took readily to the suggestion that the exploration of the interior, away from the railroad lines, which it was supposed had not been made, would be very desirable. The fact apparently was overlooked by all of those taking this view that railroads are a modern institution in Japan, and that instead of the older settlements following the lines of such roads in Japan, this is purely accidental. In point of fact the railroads strike through the country over the most available routes and often plunge through the heart of interior Japan, traversing the mountain wilds as well as the cultivated valleys, and are more apt to reach out-of-the-way districts than the older highways and roads. Furthermore, many of these lines have only just been completed, and in my trip southward the line which now runs from

^a April, May, and June, 1901.

one end of the main island to the other was not finished, and a considerable portion of the trip was made by boat in consequence.

Aside, however, from the subject of working along the railroads, which in Japan has not the same significance at all that it would in a new country like America, I may call attention to the fact that very many of my trips were across islands and into the interior far from any railroad lines and even where foreigners had never before penetrated, so that I had the novel experience on several occasions of being the first foreigner seen. I feel satisfied that my explorations covered Japan sufficiently well to enable me to form a final and correct judgment on the San Jose scale problem in that country. The explored region included the five main islands of Japan, from the northernmost island, Hokkaido, to the southernmost, Kyushu, and also the islands of Awaji and Shikoku, rarely visited by foreigners, lying to the south of the main island, both of which I crossed by jinrikisha, and, in the case of the larger one, Shikoku, surmounting a high mountain range.

In my former report, which covered one-half of the time spent in Japan, or some three months, and related to the investigation of some thirty-five of the southern provinces, or districts, it was stated that there remained to be explored the northern half of the main island (Hondo) and the northern island of Hokkaido; and, furthermore, that this northern region had a special interest on account of its containing extensive apple orchards, which are developed on very much the same lines as in America.

The heat and moisture of midsummer in Japan renders life unendurable in the low countries, and, tiding over this period, some weeks were spent in the mountain regions of central Japan, dividing the time between Niko, Chuzenji, and Yumoto, places having elevations respectively of 2,000, 4,500, and 5,000 feet. From these different places side excursions were made. The whole region covered is a mountainous one and of wild forest areas, the cultivated portion being of small amount—mere garden patches in the villages. In this region also are great imperial domains or forest reserves, and in one of these is a summer palace of the imperial family. Over three weeks were spent in these mountains and a careful study was made of the district from an entomological standpoint. Insects of all kinds were very few in numbers, and scale insects were practically wanting. The fruit trees and flowering trees grown in the private yards and small gardens, comprising such plants as mulberry, cherry, plum, and peach, were often examined, but not a single scale insect was discovered. The absence of such insects is doubtless to be accounted for by the climate. In this elevated region it is cool in summer and very cold in winter, and during the summer months the rainy season normal to the period is much intensified by the mountains catching the rain-

clouds, so that downpours are of daily occurrence and the humidity is unusually great. As a result the trunks and limbs of trees are covered with lichens, moss, and fungi. In the woods, and especially on the elevated mountain plains this side of Yumoto, were found a species of wild apple, probably a *Crataegus*, having a fruit varying from an eighth to a quarter of an inch in diameter. No means of determining the species were available. The San Jose scale had either never been introduced into this region or had failed to get a foothold, and it certainly occurred on none of the trees planted in temple and private gardens nor on the wild plants on which it might have been expected, as, for example, this *Crataegus*.

Early in August the writer left this region for an extended trip through the northern provinces, the distance being covered partly by rail and partly by boat, and side excursions were made into the interior by jinrikishas. Either going or returning, stops of sufficient length to investigate the adjacent regions were made at all the principal towns, and from several of these lateral excursions were made. In the north island the exploration covered the principal town on the southern shore, Hakodate, and a trip across the center of the island from the east to the west side, with a stop of some four or five days in the capital town of Sapporo.

Over a large region in the northern end of the main island of Japan (Hondo) Japanese settlement and complete occupation has only taken place within modern times, and there are still large areas in native grass land, the rolling nature of the country in portions of this region recalling somewhat our own prairies of the Middle West. Throughout this section and in the island of Hokkaido, which is also new to Japanese settlement, the agricultural conditions and methods are totally different from those of the older settled portions of Japan. Horticulture especially is here modeled more directly after the American pattern, and in the north island American methods of farming as well as of fruit raising are closely copied. This is largely due to the work of the agricultural college at Sapporo, where for many years were American instructors and a general introduction of American methods. This institution is continued now under Japanese direction and with a Japanese faculty, but the whole region, both in its fruit raising and general farming, reminds one very strongly of America.

The chief interest in this region comes from the fact that in the northern provinces of Hondo and in the settled portions of Hokkaido fruit raising has been developed on a scale not equaled elsewhere in Japan. The fruit raised is chiefly the apple, and the products of this region supply Japan, and to a certain extent, also, the markets of eastern Asia. The apple is grown in all this region very much as it is with us, in large orchards; the varieties are our varieties, and have been imported from America, very few European varieties having been introduced.

The apple industry in Japan, as indicated in my former communication, is of recent origin, say within the last thirty years; most of the stock has been obtained from California, and, as a rule, was undoubtedly more or less infested with San Jose scale when received. Throughout this region the San Jose scale was found scatteringly in all orchards and in all gardens. In Aomori and vicinity it was doing no very great damage in any of the orchards, but in some of the small gardens, and especially in one or two neglected ones in the city of Aomori, it was as abundant on particular trees as it often is in America. At the first investigation no evidence of parasitism was seen, but from later collections two of the parasites which attack this scale insect in America were reared in great numbers from infested branches collected in Aomori. These, as determined by Dr. Howard, are *Aphelinus fuscipennis* How. and *Aspidiotiphagus citrinus* (Craw.), the latter being the more numerous.

The Asiatic ladybird (*Chilocorus similis*) was found throughout this northern region of Japan, and evidently was an efficient means in keeping the scale in check. In certain gardens in the city where the scale was very abundant the infestation was evidently of recent beginning, a tree here and there only being very scaly, and in some instances the ladybird enemy had not yet come upon the infested plants. In other places in the city the ladybird was found in numbers, and a score were collected and put in a tight wooden box with some scale-infested twigs to determine how long the beetles could be kept safely under such conditions, as a preliminary test before attempting to ship them to America.

On the return trip to Aomori some side excursions were made by rail and jinrikisha to orchard regions toward the west coast of the island in company with Mr. Hori and some of the horticultural officers of the province. Wherever we went was found a general infestation by the San Jose scale in orchards and gardens, the scale occurring normally very scatteringly, and not at all in especially injurious numbers. Everywhere also was seen the same evidence of the scale being kept in check by parasitism by the Chalcidids which attack it in America, and especially by the predatory *Chilocorus*.

In the northern island the points especially investigated were Hakodate and Sapporo, the latter town being the capital city and, as already indicated, the seat of the agricultural college and experiment station and the center of modern agricultural and horticultural methods. The conditions, so far as scale insects were concerned, were practically the same at both of these places, and at one or two other places where more limited investigations were made, as, for example, at Mororan and Otaru.

The island of Hokkaido is even more wild and unsettled than the northern extremity of Hondo, and in fact, during the last thirty or

forty years only has there been much effort on the part of the Japanese to settle this large island and bring it under agricultural subjection. The native Aino race, with which the Japanese have been pursuing a guerrilla warfare for the last two thousand years, has now practically disappeared, and there being no obstacle to settlement, the Japanese are swarming in. Approaching Sapporo, the country becomes more settled, and many apple and pear orchards line the railway. A very careful investigation was made, covering several days, of the region about Sapporo, the studies being assisted by the various officers of the college, notably the botanist, forester, and horticulturist, and also by Mr. Hori, who was at one time a student at this institution, and who had joined me at Aomori for my northern trip. The orchards throughout this region could be given a practically clean bill of health so far as insects are concerned. The San Jose scale had practically died out, never having apparently amounted to anything here, and the only evidences of it were a few old dead scales. Nearly all the apple trees showed slight infestation by the oyster-shell bark louse, which the Japanese seem to have imported from America along with their original invoices of nursery stock. This scale insect also seemed to be having difficulty in maintaining itself and occurred in very limited numbers, those found being, as a rule, dead—living individuals being found only in protected cracks and crevices in the bark. The cherry scale (*Diaspis pentagona*) was very rare or practically absent, very few single examples being found on cherry trees. The orchards included plum, peach, and cherry, as well as apple and pear. The scale-feeding ladybird (*Chilocorus similis*) was in evidence scatteringly everywhere feeding upon *Mytilaspis*, this being the only scale insect which remained to furnish it any food. The investigation covered a number of private orchards, the orchards belonging to the agricultural college, and the parks and grounds in the city.

On the return to Tokyo from northern Japan many places were stopped at which need not be specifically noted, the conditions not being essentially new. Mito, however, a city two or three hours by rail northwest of Tokyo, deserves mention. It is the site of some very wonderful old gardens or orchards of plum trees grown not for fruit, but for the bloom. The famous orchard of this place surrounds one of the old Daimyo residences, and for many years has been a pilgrimage place for the people of Tokyo and that part of Japan in the flowering season in early spring. These old orchard trees, a hundred years old or more, covered with lichens, did not present any infestation from scale insects whatever; not a sign of the San Jose scale could be found on them. In fact, I found no scale insect in this region except a very few dead *Diaspis pentagona* on cherry.

After returning to Tokyo the orchards between Tokyo and Yokohama, which had been visited early in the year and found to be infested with San Jose scale, were again inspected. A few of the trees had been subjected to some treatment during the summer, evidently with soap, and most of the scale insects had been killed either by the soapy treatment or by ladybird enemies or parasites.

Before leaving Japan opportunity was afforded to explore another interior mountain district, viz, the great mountain plateau known as the Hakone region, and a week was spent going by jinrikisha and chair and on foot over these volcanic mountains. The native settlements are largely about Hot Springs, which have become famous as Japanese and foreign health resorts. No evidence whatever of the San Jose scale was found throughout this region, and the scale insects collected were few in amount and variety. In all this region there were old cherry trees and pear trees in house yards, but no orchard plantings of any amount.

It is impossible in this summary to give the detailed facts on which the decision as to the non-origin of the San Jose scale in Japan is based. Nevertheless, perhaps enough has been said to give a fair idea of the prevalent conditions. In a general way, it may be stated that wherever the San Jose scale was found in Japan the evidence was very plain that it had been brought in recently on young nursery stock. Very often in south Japan, where the introduction of new stock is of recent beginning, the San Jose scale is still confined to the introduced stock, or has spread very slightly to the old native trees, notably the native Japanese pear. In no case was the San Jose scale found on these native trees where there was not ample opportunity for its having come to them from new stock. In north Japan the apple industry is from twenty to thirty years' standing, and is entirely new to Japan, as already indicated, the stock having practically all come from California. Furthermore, the chief sources of nursery supplies in Japan are three establishments, located one near Kobe, another near Yokohama, and the third near Tokyo. Two of these I investigated personally and found to be infested with San Jose scale. The infestation was on the nursery trees, and also on older trees left in the general disposal of stock. In nearly every case in south Japan where the San Jose scale was found it was on stock obtained from one or other of these three nurseries, and the origin of the scale was perfectly plain. In northern Japan the introduction of foreign trees twenty-five or thirty years ago has given this scale a much wider and more general range, but even here wherever you get away from young orchards and new plantings the scale disappears. That, therefore, the San Jose scale came to Japan on American stock, and is a new enemy there of fruit trees, can not be questioned.

The Japanese are extraordinarily ambitious to equal other nations in all lines of productive activity as well as in social and political life, and hence one finds in going over the Empire an astonishing number of places where limited experiments with American fruits are being carried on in private gardens and the like, and this fact accounts for the wide dissemination of the San Jose scale throughout central and southern Japan, where fruit raising, especially of the deciduous sort, is insignificant.

It was noted also that in the more remote islands where such introductions had been little if at all made, and in districts where new stock had not penetrated, there was no San Jose scale on old native trees. Furthermore, the interior mountain regions which some have thought might be the original home of the scale are entirely free from this insect, save in rare places where it occurs on recently introduced stock.

The belief also that the absence of the scale, or its being not much in evidence is due to a natural resistance of the native fruits is without foundation. The native pear trees, when the scale is brought to them by new stock, are subject to the infestation quite as much as the foreign stock. In the case of old gnarled trees of half a century or more standing the chance of great infestation is, of course, less, as it would be under the same circumstances with the old trees in America. But young native stock seems to be just as subject to attack as foreign varieties. There is an immunity, however, in the case of the Japanese peach, but this is not complete, and is to be explained by the very rough bark developed by this tree, especially in the central and southern provinces.

Anyone studying the San Jose scale in Japan at the present time without a knowledge of the horticultural history of the country and especially its recent development, as indicated above and in my former communication, might very readily and naturally be deceived by the present distribution of this scale insect throughout the islands—as one might similarly be deceived by a study of the present conditions in America—and conclude that Japan (or America) is the native home of the scale.

Not only might the present wide distribution of the San Jose scale in Japan lead to the belief that it is there a native species, but apparent confirmation of this belief would be forthcoming in the finding, very rarely, it is true, of old native pear trees attacked by this insect with no new stock near by to account for the infestation. Two such cases were noted by the writer, and may be described to illustrate this point. Near one of the buildings of the Agricultural College at Kumamoto, in the island of Kiushu, stood an isolated old native pear tree which was somewhat infested with San Jose scale. At the moment there seemed no way of accounting for this infestation, but within a distance of not many rods was found a planting of young

apple and pear trees badly infested with scale. It was learned that this stock was obtained from the infested nursery near Kobe, which has been the chief source of San Jose scale distribution in southern Japan. Undoubtedly in this case the old native tree had been infested from this new stock. Confirming this inference is the fact that in the grounds of the experiment station, a mile or two distant from the college, and where no new fruit stock had been introduced, were a number of these old native pear trees all absolutely free from this scale insect. It may be added that both the college and experiment station are of recent establishment, and the old pear trees referred to were the remains of stock growing about the old Japanese farm houses prior to the purchase of the land for the college and experimental farms. The other instance was on the island of Shikoku, just outside of the city of Takamatsu, where a single old native pear tree growing in the yard of a farm house was found infested with San Jose scale. No young orchards or new plantings immediately about these premises were observed, which, however, did not prove that there were or had been none such. But in the old Daimyo Park, attached to the city not half a mile distant, was a lot of infested peach stock from the Kobe nursery referred to above. In every other instance where the San Jose scale was found on native trees there was new stock in the immediate vicinity to account for the infestation. Of even greater significance is the fact that in the great majority of instances such old native pear trees in dooryards throughout Japan were free from the San Jose scale and yet practically always bore a few specimens, at least, of a native *Parlatoria* and a native *Mytilaspis*. If the San Jose scale were native in Japan it should also have occurred with the scale insects just named.^a

While freeing Japan from the onus of having given the San Jose scale to the world, the investigations up to this stage left the problem unsettled as to the original home of this insect. Australia and the adjacent islands seemed to be in the same condition relative to the San Jose scale as Japan, namely, there is but little doubt that it has come into these countries on foreign stock in recent years. China remained, therefore, the only probable place of origin. In Yokohama and elsewhere I was fortunate enough to meet a number of English, American, and German residents of China who were spending the summer months in Japan, and from them I was able to get what is not given in any of

^aRelative to the recent introduction of the San Jose scale into Japan, it is interesting to note that Mr. Albert Koebele in 1895 spent several months in Japan, and failed absolutely to find the San Jose scale anywhere, and all of us who know Mr. Koebele will understand what this means, because no better collector of insects in general, and of scale insects in particular, than Mr. Koebele has ever lived. This is simply confirmatory evidence (if such be needed) of the recent spread of this scale insect throughout Japan.

the books—an idea of the fruit-growing conditions of China and the location of the principal fruit districts.

Deciduous fruits are grown from the Shanghai region northward. The peach is practically the only fruit grown to any extent about Shanghai. The great apple district of China is the region lying back of the city of Chifu in the north. The industry here started many years ago by a missionary, Dr. Nevius, has assumed very considerable proportions and spread over quite a large province, and the output of fruit is found in the markets all over central and southern China. A brief stop only was made at Shanghai in the first instance while preparations were being made for the trip to north China, the distance between Shanghai and Tientsin necessitating a five days' ocean voyage.

At Chifu an exploration was made on horseback through the districts lying back of the city, a good many orchards being visited, and notably the original orchard planted by Dr. Nevius, and the gardens and smaller orchards immediately surrounding his residence, some little distance outside of the city. Most unfortunate for the history of the fruit development of this region and of the native fruits of this part of China is Dr. Nevius's recent death. His widow, whom I met, was unable to give me any information, except that the doctor had been very active as a horticulturist during all his long residence there (thirty years), and had been the exciting agent in the development of the fruit industry of that region. His stock had mostly been obtained from America, and American varieties of apples and pears were being grown in the province. Throughout this region I found a mild infestation with the San Jose scale, with the accompanying presence of the *Chilocorus similis*.^a

The occurrence of the San Jose scale about Chifu was not significant, and threw no light on the subject of origin on account of the fact of importations from America of stock (doubtless much of it infested) and its dissemination over this province. The fact that the scale insect was not very troublesome in this region was, however, very significant, and this was evidently due to the general presence of the ladybird. Chalcidid parasitism was not common, and the scale was hardly abundant enough to develop much of such parasitism.

The next point examined after Chifu was Tientsin, and the region lying between this considerable city and its port town of Tonkoo, after which the trip was continued to the capital city of Pekin. Much of the region of China bordering the gulf of Pechili is perfectly level and flat, and only raised a few feet above the ocean. It is devoted to the growth of cereals, wheat, barley, and millet, and orchard plantings are practically wanting until one gets into the hill country lying

^a *Diaspis pentagona*, previously found throughout Japan, was also widely spread in China, occurring from Pekin southward to the Malay Peninsula and into Java, exhibiting in its range a wide diversity of food plants.

to the north and west, leading up to the Great Wall of China. My personal investigations of this region were confined to the district about Pekin and between Pekin and Tonkoo. Our minister at Pekin, Mr. Conger, kindly offered to give me an escort of Chinese soldiers to explore the mountain region north of Pekin, but I was able to satisfy myself of the conditions without undertaking this trip, which at this season of the year would have been almost impossible, and, in view of the unsettled state of the country, attended with considerable risk.

The facts which I learned here of greatest interest were obtained from the examination of the markets in the city of Pekin. To explain this it should be said that Pekin is the natural center and market for all the region lying to the north and west, and the streets devoted to the sale of fruits in the Chinese city are one of the sights of Pekin. The fruit and nut products are brought into Pekin in the little two-wheeled carts, or more generally on camel-back, great caravans of heavily loaded camels and streams of carts constantly entering the city with the products of the outlying provinces. One gets, therefore, in the markets of the Chinese city the fruit products of all northern China, and can study them at ease.

The conditions under which this fruit is grown I was fortunate enough to learn from engineers, officers, and others who had explored the region in question. All of the district lying between Pekin and the Great Wall to the north and west has been very carefully explored by the military authorities, and maps which amount to local road maps of the whole country have been made. From various individuals employed in this minute survey, I learned a great deal relative to the fruit growing of the district indicated. Much fruit is grown south of the Great Wall, chiefly along the protected valleys running southward and eastward from the mountain chain which this wall dominates. These fruits are native apple, pear, and peach, and a little wild haw apple which grows all over the hills. Of these fruits I examined quantities of all except the peach (which was now out of season) in the markets of Pekin, and later at Tientsin. Throughout all this region no foreign introductions of fruits or fruit trees have ever been made, and the fruits in the market are all of the native sorts. The pears are little and hard, somewhat like the native Japanese pear in firmness, but being elongate instead of spherical. The apples are what we term crab-apples, even the largest; and the smaller ones, which are more numerous, are not much larger than marbles, and of a brilliant red. The haw apple grows wild over the hills in this region, and is collected and shipped by thousands of bushels to Pekin and southern ports. It is of about the size of the small crab-apple just mentioned, and also a deep red, somewhat obscured, however, by a downy pubescence. This haw apple is much esteemed by the Chinese, and our min-

ister, Mr. Conger, assured me that he was very fond of the jelly which is prepared from it. It is the most abundant fruit seen in all the markets of North China, and is even shipped as far south as Hongkong. I examined a great many bushels of these different fruits, the red crab-apples and haw apples, and throughout the market I found them all infested with a scale insect which resembled exactly the San Jose scale and was later identified as such. Perhaps one apple in a hundred would have a few of these scales about the blossom end, and about the same proportion was true of the haw apple.

In making these examinations great excitement was caused among the Chinese market people, no possible explanation occurring to them for my curious and unusual conduct in overturning their baskets of apples and pawing them over and taking out one specimen out of a hundred or two, and invariably a great crowd of Chinese, jabbering excitedly, surrounded me. Occasionally finding a man who could speak a little pigeon English, I would give the only explanation which they seemed to understand, namely, that I was picking out certain minute insects, which I showed to them and allowed them to examine through my glass, which were of exceptional value as medicine. The use of insects for medicine being common in China, this explanation at once reinstated me in the esteem of all.

The finding of the San Jose scale scattered over these fruits in the Pekin market was a very interesting discovery. The haw apple is a wild fruit growing over the hills of this section of China. The native crab is the apple which has been grown in this region from time immemorial. The occurrence of the San Jose scale on these two fruits and on the native pear also has but one explanation, namely, that in this section the scale is native. The fact of its scattering occurrence is what one would expect under the circumstances, namely, in a region where a scale has always occurred it has reached the balance with its natural enemies, so that it is rarely, if ever, injurious.

The conditions indicated in the markets of Pekin were substantiated by examinations in Pekin and in Tientsin. Pekin was an utterly destroyed city and very little of residences or gardens were left for examination. Tientsin was little injured by the war, and a good many gardens were examined. Fruit growing in this region, however, does not occur to any extent, and the gardens simply exhibited a few trees and chiefly the ornamental plants of the region, notably the Chinese flowering peach, which is grown solely for its bloom, its fruit being diminutive and not edible. This peach I found nearly everywhere scatteringly infested with the San Jose scale, and always with it the ladybird, *Chilocorus similis*. This predaceous insect seemed to sustain the same rôle throughout north China as in Japan. At Tientsin, through the courtesy of the German medical authorities, I was able to make a microscopical examination of the scale insects, and demonstrated beyond question that they are the San Jose species.

Returning later to Shanghai, after making another short stop at Chifu, I made a thorough examination of the peach-orchard district lying to the west of this city, and in these orchards I found not a trace of the San Jose scale. Later I examined several of the small Chinese nurseries and gardens in and about the city, and in one of these nurseries I found on some young stock the San Jose scale. It was dying out, however, and evidently the climate of Shanghai and southward in China is not one which the San Jose scale can successfully endure. The difficulty is probably due to the excessive heat and the accompanying great moisture of the rainy season of summer, which probably develops a fungous disease and exterminates the scale. The plants of this whole region are notably free from scale attack, with the single exception of the holly, which is usually considerably infested with wax scale, *Ceroplastes* sp.

Later I made a trip into the interior of China from Shanghai by houseboat, examining orchards and house plantings en route, but without finding a trace of the San Jose scale anywhere, nor any other scale insect, except in one or two instances. The greedy scale (*Aspidiotus cydonia*?) was found once on a few twigs only, and an occasional very slight infestation, represented by a few specimens only, of the *Diaspis pentagona*, all bearing out the idea that the climate of this region is not suitable to the ready multiplication of scale insects.

Below Shanghai one gets into a subtropical climate, and the orange, pomelo, and mandarin take the place of deciduous fruits. My entomological explorations were continued very briefly at Hong Kong, in south China, where in the markets I found the haw apple and crab apple from north China, and with considerable thoroughness in the British Straits settlements about Singapore and in Java, and later in Ceylon and the various points touched en route home. The San Jose scale story, however, ends with Shanghai.

The question immediately suggests itself, why was not Japan early infested with this insect from her near neighbor, China? This would be expected as the natural and early result of the contiguity of the two countries. The explanation is forthcoming when the history of the political relationship of these two countries is investigated. China and Japan have been sworn enemies and jealous rivals in all past time, and commercial and friendly intercourse between the two countries has been practically wanting. Japan, it is true, has taken her alphabet and much of her learning and civilization from China, and 600 years after Christ her Buddhist religion also, which now divides honors with the native shinto religion of the country. All this has come to Japan, not from China direct but through Korea. Japan conquered Korea very early in the present era, 200 A. D., in the reign of the famous Empress Jingo, and has ever since claimed and exercised a greater or less sovereignty over this country. Reference to the

map of Asia indicates furthermore that Japan is not directly opposed to China, but to Korea and what is now Russian territory and Manchuria, and if she obtained any deciduous fruits from the continent, they came from Korea and not China. The orange and subtropical fruits were brought from the south, and in modern times whatever trade has been with China through the agency of the Portuguese and Dutch has been with the southern ports, where the San Jose scale does not exist.

Practically the only relations which China has had with Japan anterior to the opening of the latter country to the commerce of the world was the sending early in this era of certain embassies demanding tribute from Japan. The reply to these embassies was to send back the heads of the ambassadors. Following this, two efforts were made during the reign of Kublei Kahn to conquer Japan. In both instances the enormous fleets of the great Mongolian conqueror were utterly destroyed by a hurricane, and every Mongolian or Chinaman that succeeded in escaping the waves and getting ashore was promptly decapitated by the waiting Japanese. The Japanese made no attempt to conquer China until their notably successful war of 1895.

It will be seen, therefore, that there has been very little chance of commercial intercourse between these two countries, and this explanation seems to be the chief one in accounting for the failure of an insect common in the region north of Peking to reach Japan. Furthermore, it may be said that the commercial intercourse which has sprung up so actively in later years with Japan has been, so far as fruits and trees are concerned, solely with the region from Shanghai southward, and the introduction of fruits and the like has not been from China to Japan but the other way, and it is quite possible that the San Jose scale which I found at Shanghai was imported from Japan on stock sent over to the local Chinese nurserymen.

As a matter of interest it may be here noted that the native home of the San Jose scale in China is a fairly well shut-off region, and this accounts probably for the failure of this insect to become a world pest ages ago. The district in question is the hill region leading up to the mountains and Great Wall and comprises the northern and north-western frontier of China proper. Beyond the Great Wall on the north and west lies Mongolia, consisting chiefly of the vast desert of Gobi; to the northeast and separating the region from Manchuria and Korea is the little Gobi Desert; to the south and east lie the great alluvial plain, the product of centuries of mud carried down by the Yellow River—a region where cereals only are grown.

These are all effective barriers, and especially so when considered in connection with the political conditions of the past. The alluvial plain on the southeast is not now and seems never to have been devoted in the least to fruit, and farther south the climate becomes unfavorable, as already noted.

We have, therefore, as the original home of this insect a naturally shut-off area from which it could not easily escape under the conditions prevailing up to our own times.

The means by which the San Jose scale came from China to America is a matter of interest and offers room for conjecture. The San Jose scale apparently reached California on trees imported by the late James Lick. It was known that this gentleman was a great lover and energetic importer of trees from foreign countries, and my own belief is that he imported from China, possibly through this same Dr. Nevius or some other, the flowering Chinese peach, and brought with it the San Jose scale to his premises. At any rate, I believe that this insect, which should now be known as the *Chinese scale*, came to this country on some ornamental stock from North China.

PRELIMINARY REPORT ON THE IMPORTATION AND PRESENT STATUS OF THE ASIATIC LADYBIRD.

(*Chilocorus similis*.)

By C. L. MARLATT, *Washington, D. C.*

In this place a brief account only will be given of the importation of this ladybird and of the present outlook of the experiment. A detailed account of this insect, giving full life-history studies and other points of interest, will be published elsewhere. It has already been indicated in the foregoing account of the search for the San Jose scale in China and Japan that this ladybird was everywhere present in both of these countries, feeding on the San Jose scale and *Diaspis pentagona*. The latter scale insect, as was pointed out, is common to all eastern Asia, including Japan, and the East Indies, and undoubtedly, from its wide distribution and local occurrence in most out-of-the-way districts, is a native of this region and has been spread about in times so remotely past as to be beyond determination. It is probably a tropical species which has worked northward until practically the whole region as far as Peking, in China, and the north island of Japan has been covered. Whether the ladybird, *Chilocorus similis*, was in ancient times the natural enemy of the *Diaspis* can not be determined, although the more wide occurrence of the *Diaspis* might lead to this idea. This ladybird, however, like other members of its genus, is a general feeder, and will attack other scale insects, even the young of the unarmored scale insects as well as the *Diaspine* scales. Wherever it was found with the San Jose scale, however, it was very evident that it fed on this scale insect with perhaps even greater readiness than it did on the *Diaspis*, and in our experimental breeding cages in Washington it has bred faster and done better on the San Jose scale than on the *Diaspis*.

After finding this ladybird so generally present with the San Jose scale, and apparently so efficient in keeping the latter within reason-

able limits, the desirability of introducing it into America was very evident. While in Japan I was unable to determine whether Mr. Albert Koebele, in any of his numerous importations, had sent this ladybird into California, but it seemed more than probable that he had done so, and I wrote to Mr. Koebele, at Honolulu, H. I., and some months later after I had made my shipments I received information from him that he had sent a lot of material to Mr. Alexander Craw, and that the latter had carried it through the winter successfully, but further than that he knew nothing of it. It is possible that the material introduced by Mr. Koebele has established itself in California. Since my return from the Orient, and within a few days, I have learned from Prof. J. B. Smith that he also had had some specimens of this insect sent to him from Japan by one of his Japanese correspondents. These were liberated at once in the fall in an infested apple orchard in New Jersey and nothing has been seen of the insects since, Professor Smith believing that they perished. Judging from the small percentage of survivors of those which I imported, I think it very likely that Professor Smith's specimens all died during the winter.

As a preliminary experiment to determine the possibility of shipping them across the ocean I collected, about the middle of August, a lot of the beetles in North Japan on trees infested with San Jose scale and carried them about with me in my travels for over two weeks in a tight wooden box with some infested twigs as food. These beetles, kept under conditions which certainly were not very favorable, being among other goods in my baggage, and subject to much shaking, came through the ordeal in perfect condition, and I shipped them to Washington with a lot of others collected, with the assistance of Mr. Hori, about Tokyo.

Three packages were sent about the middle of September, and of this first sending some twenty odd specimens reached Washington in fairly good condition, active, and apparently uninjured, and Mr. Kotinsky, who was given the beetles in charge, from his records is able to say definitely that it was individuals from this first sending that successfully overwintered. A sending two weeks later was made from specimens collected about Yokohama and Tokyo, together with a few taken in the interior hill region. A third sending was made from material collected about Tientsin and later at Shanghai, the specimens at Shanghai being found feeding on the young of a wax scale on holly, the beetles occurring there in considerable numbers. The distance from Shanghai to America by boat is a week or ten days longer than from Japan, and six or seven weeks are required for their arrival at their destination in Washington. The sendings from China were received in rather poor condition, and Mr. Kotinsky assures me that all of the specimens of this lot which were alive when received died during the winter.

On leaving Japan I had made arrangements with the entomological

authorities of the Central Experiment Station at Nishigahara, near Tokyo, to make additional sendings, and a little package was received early in the spring of 1902 from the chief entomologist of the station, Mr. Onuki. This material, however, came in a very bad condition, and the few surviving beetles soon perished.

The material shipped in the first instance by me was in three wooden boxes, two sent through the mails and one personally carried across the Pacific by Miss Laura Bell, whom I had met in Japan, and who kindly promised to mail it to Washington as soon as she landed in Vancouver. All of this material and the subsequent sendings also, so far as I could control them, were mailed to take the Canadian Pacific steamers to get the advantage of the northern and much cooler as well as shorter passage. I am unable to determine, the record having been lost, whether the specimens which overwintered were those personally carried by Miss Bell or those sent through the mail. At any rate, but two individuals survived. It is possible that with proper precautions a much larger number could have been successfully hibernated, but they were kept indoors, and for part of the time in heated rooms, and the survival of two was, under the circumstances, a rather fortunate outcome. Furthermore, many of the beetles were possibly spent ones when collected.

In April, after the eggs were recognized, the beetles and eggs were transferred to and kept in a jar in the greenhouse on fresh scale-infested twigs until larvæ were produced in considerable numbers. Undoubtedly a good many of the eggs first laid were overlooked because of the peculiar habits of oviposition of the beetle, which seem not to have been previously noted. Later on the eggs were discovered and some 50 larvæ were reared in this manner indoors. Afterwards the beetles and the larvæ were from time to time transferred to a big out-of-door cage, 6 feet square and 9 feet high, inclosing a plum tree thickly infested with *Diaspis pentagona*. Ultimately all of the indoor-bred larvæ were transferred to this tree, about 100 altogether, and, judging from the rate of oviposition, at least 100 additional eggs were deposited on the tree by the parent beetle before the latter perished. So far as we could determine, but one of the two surviving beetles was a female, and 200 eggs or more were obtained from her after a good many had been lost or thrown out with the wood on which she had been feeding before the eggs were recognized.

The life period of these beetles is evidently considerable. The two imported ones which survived the winter were active and vigorous until about the end of May, when they perished, the supposed male preceding the female by about a week or ten days. They, in other words, had been kept in captivity for nearly a year, having been collected early in September. This would indicate a life period of at least twelve months, because they were necessarily more than a month

old from the egg when captured, and their lives were probably shortened by the unusual conditions and experiences to which they were subjected. This long life is of very considerable importance in considering the value of these insects as exterminators of the San Jose scale. Their fecundity is also considerable, as indicated by the actual securing of some 200 eggs from an imported specimen and under unfavorable conditions, not counting the loss of a good many eggs. It is not improbable, therefore, that a single female may be the parent of at least 500 young, and the period of usefulness of an individual may extend over twelve months.

The egg is normally concealed under an adult female scale. In other words, the beetle selects a suitable scale, drags out the female scale insect, and either eats it while ovipositing or drops it, turns about and thrusts the ovipositor under the slightly lifted edge of the scale, and in two or more minutes deposits a single egg. This habit of oviposition seems to be peculiar to this species. It was found later on, when the beetles became more numerous, and especially during the period when the old female San Jose scales were not so abundant, and the trees were covered with young scale insects, that other locations would be chosen by the beetle for oviposition, namely, under the loose edge of bark or like situation, or more rarely eggs would be deposited exposed on the bark.

Later in the summer other large cages were built over some pear trees infested with San Jose scale. In all five such cages were built, each of the four later ones including two pear trees about ten years of age but cut back to small size. In these cages the beetles thrived wonderfully well. One cage in which two individuals, a male and a female, were placed in May, was swarming with beetles by the middle of July, and more than 100 beetles were taken from it for distribution elsewhere without greatly lessening the stock.

The multiplication of the beetles at this stage was fairly satisfactory, not so much so, however, as it should have been if the experiment had not been interfered with by the presence of certain predaceous insects to be considered later, notably the wheel bug, two species of praying Mantis, lace-winged fly larva, and the larva of *Adalia bipunctata*, it being almost impossible to free these rather large cages from all of these insects. In spite of all the drawbacks, however, the beetles have multiplied to exceed 500 specimens, perhaps 1,000, by the 1st of July from the single overwintered pair, but one of which was presumably a female.

We are making arrangements to ship these beetles to the entomologists and State experiment stations this summer and fall, and we hope to establish this ladybird in the eastern United States. It feeds voraciously on the San Jose scale and on the Diaspis. The larvæ are eating all the time, and the rate of multiplication is such that five annual

broods may be counted on, the third brood in our own breeding cages being under way in the latter part of June. Whether this ladybird enemy of the San Jose scale will really amount to anything as an efficient means of controlling this pest remains to be demonstrated. The San Jose scale is its normal and natural food. It multiplies rapidly, and a larval *Chilocorus* destroys an enormous number of young scale larvæ in a day, by actual count 1,500 per day or about one a minute, but while actively feeding at the rate of 5 or 6 a minute. The main question to be decided is whether this insect can be successfully established in this country, and if so, whether our native predaceous insects will allow it to yield the full benefit which it should give in keeping down the San Jose scale. We make no extravagant claims, but believe that the experiment is well worth trying, whatever may be the outcome."

It has been suggested that this ladybird is the same as our native species, *Chilocorus bifenestrus*, and, in fact, the superficial resemblance of the adults of the two species is so close that the greatest difficulty will be found in distinguishing them. The larvæ of the two species, however, are distinctly different in general appearance. The Asiatic has the skin of a reddish or flesh tint, the spines being black but less prominent than in our native species. The skin of our native species is a dull gray, and the general appearance of the larva, therefore, is decidedly black or dark, whereas the imported species, when full fed, is reddish. Furthermore, there are structural differences in the spines and hairs which will enable one readily to separate them irrespective of the difference in appearance, which is very striking. The beetles also can be separated, as I am assured by Mr. E. A. Schwarz, although careful anatomical and structural studies have not been made at this writing. The imported species is notably smaller on the average than our native species, and rather more brilliantly colored, and differs a little perhaps in the general shape or convexity of the wings and thorax. Furthermore, it feeds on the San José scale and the Diaspis naturally and normally. Our species, while it is often found in scale-infested orchards in the East, has never done very much good in the orchards, and does not feed and multiply on the scale in the way that it ought. For example, in the grounds of the Department of Agriculture this year we have a little orchard of pear trees thickly infested with the San José scale—the orchard in which we are establishing this foreign ladybird—and yet in all the time during the spring and early

"It may be added to the above that during the balance of the summer this beetle did very well in the little Department grove. About a thousand beetles were distributed to various entomologists, from some of whom reports of considerable success have already been received. In Washington breeding seemed to stop toward the end of September, but we now have more than 2,000 beetles which will be overwintered. Next year we should have them in quantities for general distribution.

summer of this year that this orchard has been under constant and careful observation but one or two beetles of our native species have appeared, and but two of its larvæ have been seen on the trees. Yet within a stone's throw of this orchard is a tree on the grounds of the Department infested with *A. ancyllus*, and on this tree, infested with a native scale insect, the *Chilocorus bivulnerus* has established itself in considerable numbers, probably several hundred larvæ being present on the tree. The history of this ladybird in the East, and as further illustrated by the instance just mentioned, seems to indicate that it prefers our native scale insects and has not yet fully accustomed itself to the San José scale nor to the recently introduced *Diaspis pentagona*. It may take hold of these new scale insects in the course of years, but it certainly does not do so at present in a manner to be of any great assistance in keeping them in check." In Florida and California especially on Citrus trees it is very abundant, as a rule, and an efficient enemy of scale insects. The imported species feeds normally and voraciously on the San José scale and *Diaspis*, and, if it survives our climate and can be established, we may hope that it will accomplish for us some, at least, of the good results which it was seen to achieve generally for China and Japan.

In the matter of climate, it may be said that the region in which it occurred in China and Japan will duplicate nearly enough the eastern United States or California. We have about the same summer and winter temperature and similar general conditions of rainfall and other climatic features, so that from this point of view there seems to be no reason why the imported ladybird should not do well.

That this ladybird or any other parasitic or predaceous insect will ever completely subdue the San José scale in the United States is very problematical, and there is very little doubt but that in future, as in the past, to free an orchard from this scale pest it will be necessary to take the direct and active means now being employed, such as the use of oil, or the lime, sulphur, and salt wash, or other remedies which experience shall demonstrate to be effective. What parasites or predaceous enemies may do is to keep this scale in check so that it will not be so generally abundant and destructive, and especially to keep it down in the thousands of small orchards and gardens where direct spraying operations would not often be undertaken by the owners.

In particular districts it may even put a complete check on the San Jose scale for one or several years. That this is possible is indicated

^aToward the end of July some 26 specimens of the native *Chilocorus bivulnerus* were caged over a San Jose scale-infested pear tree to make comparative studies of the life history and habits of the species. Unfortunately, however, all of these beetles perished, without our securing either eggs or larvæ. This rather astonishing and unexpected outcome seemed to be due to a distinct disinclination on the part of these beetles to eat the San Jose scale except in the most sparing manner.

The observations and experience of this spring have brought into question the real value, as aids to the fruit grower, of the four predaceous insects mentioned and others of the same class which have general feeding habits. The evidence points very strongly to the conclusion that such insects do more harm by destroying beneficial species like the ladybirds feeding on scale and plant-lice than they will ever do good by eating larvæ or other soft-bodied plant-feeding insects. In other words, the injurious insects which they may feed upon to a greater or less extent are almost without exception species which are very easily controlled by other means, viz, by insecticides or methods of cropping. On the other hand, the beneficial insects which they destroy, as notably the larvæ of ladybirds, which feed on plant-lice and scale insects, include a group of insects of special importance and value to the horticulturist, for the reason that they feed on insects which are not easily controlled by other means, and which, if kept in control by natural enemies, may never require the expensive and, to the plants, dangerous treatment necessary to effect their artificial destruction. As a general proposition, therefore, I am inclined to rank all general-feeding predaceous insects as injurious and distinctly prejudicial to the interests of the horticulturist and farmer. The introduction, therefore, of any such insect, as, for example, the European *Mantis religiosa*, or efforts at their wider dissemination, are mistakes, which, in my opinion, will come to be regretted very keenly in the future. Instead of protecting these insects, I believe it will be much more to the general advantage to destroy all egg masses of mantids and the wheel bug; and to view the lace-winged flies with suspicion, if not to class them as absolute foes.

ADDENDUM.

A very important hymenopterous parasite must be added to the list of natural enemies of the Asiatic ladybird. To our very great disappointment and astonishment, early in September it was found that the pupæ of the last brood were much parasitized, causing a loss of more than 10 per cent of this brood. As many as could be of these parasitized pupæ have been collected, and from them has been reared a little Chalcidid fly, *Syntomosphyrum esurus* Riley, from five to seven parasites coming from each pupa. This insect belongs with a group of secondary parasites, but no trace of the primary parasite could be found in any of the pupæ examined, although later breeding may develop the primary parasite during the winter or next spring. The larvæ were found free in the abdominal cavity of the Chilocorus pupa, and ultimately all of the substance of the pupa disappears. In one or two cases where parasitism had only just begun to make itself evident, half-grown larvæ were found. These were filled with the yellow fluid contents of the Chrysomelid, and were orange yellow in color. The

older larvæ in the nearly empty shells of the pupæ were whitish in color. That all of these larvæ are of the parasite mentioned above can not be definitely said. Dr. Howard, who examined the material with the writer, is of the belief that the primary parasite will prove to be *Homalotylus obscurus* How., the common coccinellid parasite of this country. If the parasite bred proves to be a true secondary parasite, as believed, its presence in such numbers in the pupæ of *Chilocorus* is a matter for gratification. If, on the contrary, it be a primary parasite, it seriously threatens the success of the imported *Chilocorus* and all allied ladybirds. The status of this parasite is given in the appended note by Dr. Howard:

All of the Tetrastichinæ known and whose exact host relations have been determined are hyperparasites. *Syntomosphyrum esurus* Riley has never been proved to be either secondary or primary. It is or was a common parasite of *Aletia argillacea* in the cotton fields of the South late in the summer. It issued frequently and in great numbers from old chrysalids left hanging bare upon the cotton stalks. The chrysalids on being opened were found full of this parasite, and no trace of a primary parasite was ever found. Hence this insect was considered in Bulletin 3 of the United States Entomological Commission, and in the Report on Cotton Insects, by J. H. Comstock, published by the Department of Agriculture in 1879, to be a primary parasite. The question as to whether it might not be a secondary parasite was raised by me in the Fourth Report of the United States Entomological Commission. It was reared, as recorded in Bulletin 5 (Technical Series), of this Division, by Dr. A. D. Hopkins, at Morgantown, W. Va., from *Orgyia leucostigma*. It was reared abundantly in 1896, in the late winter and early spring, at Washington, D. C., from the chrysalids of *Hyphantria cunea*. Moreover, it was reared by F. M. Webster, in 1889, on May 3, according to the notes of the Division, from the galls of *Trypeta gibba* Loew on *Ambrosia artemisiifolia*. But these *Trypeta* galls, especially late in the season, are apt to contain several different kinds of insects, not only primary parasites, but frequently lepidopterous, coleopterous, and dipterous larvæ, so that the rearing from the gall means nothing at all; the presumption, however, being that the insect came from the *Trypeta* either as a primary or a secondary parasite.

Summing this evidence all up, we have the insect reared undoubtedly from lepidopterous chrysalids and from coleopterous chrysalids—that is to say, the Coccinellids under consideration—and also possibly from dipterous insects. Unity of habit—that is to say, unity of host relation—is so marked among the Chalcididæ that wherever such a diversity in the apparent hosts occurs it has become my rule to place such parasites as undoubtedly secondary or tertiary parasites. The primary parasites of a given group of insects belong to certain definite groups. Examples are so numerous that they need not be mentioned. In no case in the whole family, to my knowledge, are the parasites of a single genus parasitic upon more than one order of hosts, and in some instances they are confined even to individual families of hosts, and the assumption that a single species of Chalcidid may be reared from Coleoptera, from Lepidoptera, as well as possibly from Diptera, is almost an absurdity. These are the principal reasons upon which I base my belief that *Syntomosphyrum esurus* is a hyperparasite.

After the reading of these papers they were opened for discussion.

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After the reading of these papers they were opened for discussion. Mr. Webster commented on the value of what Mr. Marlatt had accomplished, and felt that the least the Association could do was to

extend to him a vote of thanks. He then made a motion to that effect. Mr. Webster, continuing, stated that it would have been exceedingly interesting if Mr. Marlatt could have gone to Korea, but doubtless this was not possible. The main object, however, was accomplished. He wondered if Mr. Marlatt would not have had as good success with material gathered from Europe instead of Japan and China. He did not consider that there was quite so much danger from our native predaceous insects as Mr. Marlatt had suggested, and called attention to the value of the twice-stabbed ladybird in clearing maple trees badly infested with the common maple *Pulvinaria*. The occurrence of *Chilocorus similis* in Europe would indicate that it had a variety of host insects, and that it would feed on almost any species of scale. The insect, however, seemed to have acquired a greater taste for the San Jose scale than any other of the scale insects, and he thought that it would gain about the same status of importance and abundance as other native species, but that it would probably be a little more fond of *Aspidiotus* and *Diaspis* species than is *C. bicul-nerus*. Mr. Webster was very glad that the studies in Japan and China had been made, and thought American entomologists had a great deal to thank Mr. Marlatt for.

Mr. Scott rose to second the motion made by Mr. Webster. He considered this one of the most important attempts in experimental entomology, and thought Mr. Marlatt was to be congratulated as contributing such valuable work along this line.

The president then put the motion, and it was heartily carried.

Mr. Smith stated that Mr. Marlatt's paper had interested him greatly, and he considered that the most important feature of the work was that Mr. Marlatt had shown that China was the native home of the San Jose scale, and that it was there kept in check by native insects. The question had always been, however, whether the enemy which kept it in check in its home would do the same in the eastern United States. He felt satisfied from investigation in California that our native species was there one of the most active enemies of the San Jose scale. He had found there, quite early in the season, that not only had there been a brood of the ladybird larvæ before the scale began to breed, but that eggs were already scattered over the trees for a second brood. He had seen larvæ as well as adults feeding on the dormant scale. He felt quite certain that this was the insect doing most good in keeping the scale in check in that State. Just why the beetle would not breed with us in the East as continuously he was at a loss to explain. He had watched it for several years, and was convinced that it did not have more than two broods a year in New Jersey. He stated that the beetles were eating on his trees at present, but not at the same rate as in California. He had found them on trees that had never been treated as well as on those which had been treated.

He had in his experiment orchard a number of trees that had never been treated, which showed resisting qualities and did well. The scale never increased beyond a certain point, and then practically died off. He had never found any wheel bugs in this orchard, so that these could not be considered in accounting for the disappearance of the ladybirds. They should hardly rank as enemies, but might form an important factor in the destruction of the larvæ of this ladybird beetle if it really appeared in considerable numbers. He knew that many of our predaceous insects eat a great variety of food. The wheel bug will eat a webworm, the larvæ of the elm-leaf beetle, or anything else in its way with equal pleasure.

Mr. Smith had been able to determine positively that the larva of the two-spotted ladybird eats the young crawling scale larvæ. He thought, as a result of his observations in California, that there was a possibility that the California species of *Chilocorus* was different from our Eastern form, though they were quite similar in appearance. He had had a number in the early stages and could not make out any difference between them. One year 200 California specimens had been sent to him, and in comparison with the Japanese specimens and those from the eastern United States he was not able to tell which came from one place and which came from the other. To secure the lot that had been imported from Japan, he wrote to every entomologist in that country whose address could be secured. Individual letters were sent, with offers to pay all expenses, and in this way a considerable number of two species were secured, one a large form, the name of which was not remembered at that moment, and the other a smaller species, *Chilocorus similis*. These beetles were taken to a very scaly orchard and liberated on the trees at a season of the year when all stages of the scale were present, and when there was an abundance of time for the beetles to deposit eggs. So far as he knew there had been no survivors. He had not been able to find any larvæ and had not recognized the difference between those of the twice-stabbed ladybird and those of the *Chilocorus similis* until Mr. Marlatt had pointed it out in his paper. He considered that Mr. Marlatt was very conservative in his claims in regard to the imported beetles and thought his suggestions well worth the trial. He was in doubt as to the importance of the injury resulting from the wheel bug, but stated that this species did considerable good in controlling the fall webworm. In response to a query, Mr. Smith stated that the *Chilocorus similis* had been placed in the orchards referred to three or four years ago. He further stated that the orchard had been pretty well cleaned of scales by other means, but that he had never seen any descendants of the imported insects.

Mr. Sanderson observed that *C. bicalnecrus* was very common in Delaware and that he knew of several orchards where it kept the

Forbes scale in check. The Forbes scale would sometimes become quite injurious and peach trees would often be killed. It was his observation that the *C. bivalveus* was largely instrumental in controlling this species, and while he had observed the wheel bug to be very common, yet he had never noticed that it fed on the larva of this beetle.

Mr. Felt stated that he desired to congratulate Mr. Marlatt on his efforts in searching for the native home of the San Jose scale and procuring its natural enemies. He stated that there were no wheel bugs in New York State, so that this insect could not have a hand in destroying parasites. He stated that there were very few of the *C. bivalveus*. So far as his observations went, he considered the ladybirds most valuable as enemies of plant-lice. Plant-lice were very abundant in Albany in 1897, and ladybird larvæ were so very numerous as to attract considerable attention.

Mr. Hopkins remarked that there was great difficulty in determining the different species of closely related scolytid beetles, and suggested the importance of a close study of closely related species in all stages to definitely determine their distinctness. As an example, two scolytids had been described from Germany as different species, but were afterwards considered the same. After a close study, however, he had found that the two European species belonged to two quite distinct genera. On close study he had found striking differences, not only in habits, but in structure.

The next paper was presented by Mr. Quaintance.

ON THE FEEDING HABITS OF ADULTS OF THE PERIODICAL CICADA.

(*Cicada septendecim* L.).

By A. L. QUAINANCE, *College Park, Md.*

But little accurate observation seems to have been made on the feeding habits of the adults of the periodical cicada, or so-called seventeen-year locusts. A review of the rather scant literature on the subject indicates also that considerable diversity of opinion prevails among entomologists and others as to the extent to which they feed, and, on the whole, the opinion probably prevails at the present time that the adults, particularly the males, feed but little, if at all, during their brief aerial life of about thirty days. The first note in reference to this point which I have seen is by Messrs. Walsh and Riley, in the *American Entomologist*, Vol. I, p. 67 (1868). It is here stated, under a general discussion relative to the sting of the periodical cicada, that "the beak is an organ which both sexes of the cicada possess, and by which they take their nourishment. We have

ourselves seen them insert it into and extract it from the branches of different trees, and know that the operation is quite rapid and that the instrument is quite sharp and strong." The same statement was repeated by Professor Riley seventeen years later.^a Professor Riley also adds a note in reference to an experience of Mr. Gustavus Pauls, in which an apricot tree was so severely injured by the puncture of their beaks in the course of feeding that he took from the tree a gallon of coagulated sap; and he attributes the death of some of his trees to this cause. In the course of his observations on the seventeen-year locusts on Staten Island in 1894,^b Mr. W. T. Davis says: "The black birch and sweet gum were also great favorites, both as depositories for the eggs and also from which to draw sustenance. It was no uncommon matter to see rows of cicadas along the branches of the sweet gum, each insect with its proboscis stuck into the bark." He also adds, speaking of sumach (*Rhus glabra*): "Though the cicadas were fond of sucking the sap of this bush, yet they rarely tried laying eggs in its tissues."

According to Dr. J. B. Smith,^c "very little injury is done in feeding, the food consisting of sap of trees of many kinds." Dr. A. D. Hopkins^d states that the adult cicadas feed but little, if at all.

In our latest and most authoritative report on this interesting species, Bulletin No. 14, new series, Division of Entomology, United States Department of Agriculture, by Mr. C. L. Marlatt, it is stated, doubtless after due consideration of all the evidence bearing on the subject, under the caption "Food habits of the adult insects," p. 72, that "the taking of food in the adult stage seems to be of rare occurrence, and has been observed and commented on by a few of the entomologists who have studied the species. That the periodical cicada feeds at all has even been questioned, and it is quite possible that in some of the cases where it was supposed to have been feeding, the action of the insect was misinterpreted. Such feeding is limited, at any rate, to the female, as in this sex only do we find a perfect digestive apparatus, that of the male being rudimentary."

My attention was called to this question during the height of the abundance of the present brood by the receipt of a letter from a correspondent to the effect that the cicadas were feeding on his orchard trees, and desiring a remedy. After writing him to the effect that he was doubtless mistaken in his observations, as the cicadas fed but little, if at all, in the adult stage, a visit the following day to a near by orchard of three or four-year-old apple and pear trees showed that

^aBulletin 8 (o. s.), Div. Ent., U. S. Dept. Agric., p. 14.

^bNat. Science Association of Staten Island, Vol. IV, No. 9, September, 1894, pp. 33-35.

^cBulletin 95, New Jersey Agricultural Experiment Station, p. 5.

^dWest Virginia Expt. Sta. Bul. 50, p. 9, and Bul. 68, p. 265.

the insects were there in great numbers and were feeding quite generally. On practically every tree both sexes were to be observed, ranging in numbers from 10 to 40, with their beaks stuck straight down against the bark, to all appearances feeding after the usual manner of homopterous insects. In numerous instances the insects were observed, when disturbed, extracting the thread-like setae from the plant tissue. The insect occurred most usually, in this young pear and apple orchard, along the trunks and larger limbs, which, early in the morning and rather late in the evening, were frequently quite wet with sap which had exuded from the punctures made by the setae of the cicadas. This exudation of sap was frequently noticed to immediately follow the withdrawal of the sucking apparatus of the insects to such an extent as to run down the trunk a distance of 4 or 5 inches, and the loss of sap in this way and that taken up by the insects would apparently be a considerable drain on the vitality of the plant.

Since the date of making the above observation at College Park on June 5, I have paid special attention to the feeding habits of the cicadas in other parts of Maryland, where my work has taken me, and without exception, in every place visited throughout the range of the insect, both sexes have been observed to be feeding in greater or less abundance. At Hancock, in Washington County, the cicadas were very numerous in a young apple orchard, from 6 to 18 being noted on the several trees closely examined. At Annapolis Junction, in an orchard of two-year-old peach trees, the insects were exceedingly abundant, both feeding and ovipositing. On one undersized tree in this orchard twenty-four cicadas were counted, each with its beak stuck straight down against the bark, and the tree was quite wet along the larger limbs and trunk by the sap exuded from the punctures made. In large oak, maple, and probably other trees, the insects feed very generally in the higher parts of the tree on the more tender branches and limbs. I have been able to establish this by numerous observations with an opera glass from the higher windows of the several college buildings, which are surrounded with large trees of doubtless the original forest growth. This habit of feeding in the higher parts of forest trees will doubtless account to some extent for the opinion that but little, if any, feeding is done, since here there would ordinarily be but little chance of observation. While no attempt was made to determine the various plants used as food, the cicada was observed feeding on the following: Apple, pear, peach, Japan plum, maples and oaks of several species, Carolina poplar, elm, hickory, and *Hea opaca*.

To determine more definitely the extent to which the beak and setae of the cicada were inserted into the tissues of the food plants, many beaks were snipped off, by the use of a fine pair of scissors as close to

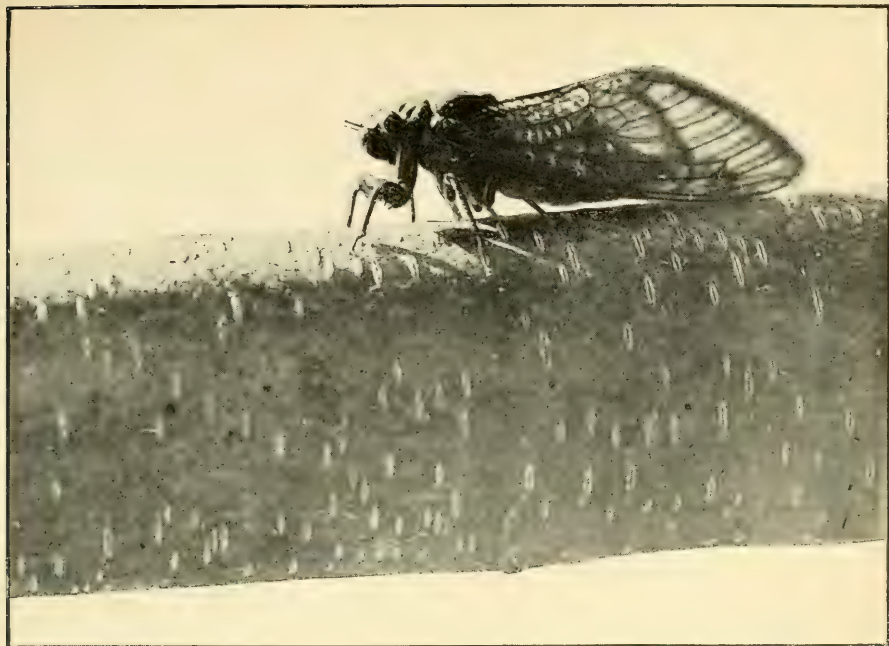


FIG. 1.—CICADA IN THE ACT OF FEEDING.

About twice natural size.



FIG. 2.—BEAK AND SETÆ OF MALE PERIODICAL CICADA IN WOOD OF CAROLINA POPLAR.



FIG. 3.—SETÆ OF FEMALE PERIODICAL CICADA IN APPLE TISSUE.

Much enlarged—original.

their origin as possible, while the insects were in the act of feeding. A block of wood containing the setæ was cut from the tree and sectioned with the microtome (Plate I). The accompanying photomicrograph illustration shows a section thus prepared with the beak and setæ inserted. The beak, in this case, was taken from a male feeding on the Carolina poplar. Many sections have been made, and show no appreciable points of difference from the one illustrated. It will be noted in the illustration that the sheath penetrated somewhat into the bark, but is not pushed into the harder wood. In all specimens examined, this seems to be true, the beak being pushed only slightly into the outer bark, while the setæ are thrust to variable depths into the cells of the plant.

Despite this evidence as to the fact that the adult cicadas feed, which in the case of almost any other insect would have been convincing, doubt has recently been expressed as to whether it could be considered true that the cicada feeds in the sense of taking nourishment. The use of the mouth parts as above illustrated was considered to be the result more of hereditary instinct than anything else, and, while it was admitted that the beak might be thrust into the tissues, this was considered to be simply a sampling or tasting of the juices of the plant on the part of the insect. At various times, but particularly rather late in the evening, both sexes of cicadas have been taken from trees in the act of feeding, and quickly opened, so as to expose the stomach, or so-called crop, and this has been found in many instances to be distended several times its usual size with the sap taken from the trees.

According to Marlatt (l. c.) the alimentary tract of the male is considered to be rudimentary, and no food is taken by this sex. As shown in the foregoing, males have been observed many times in the act of feeding, and the photograph to which attention has been called shows the setæ of a male in the tissues of the plant. Males, as well as females, have been taken in the act of feeding, and their stomachs found distended with sap. Furthermore, dissections of the alimentary tract of the male shows that it is not rudimentary, but apparently normally developed for this group of insects. The intestine, while small, is continuous to the anus, and is reasonably large for insects subsisting on liquid food. The œsophagus and salivary glands are well developed, while the stomach and crop is rather large and capable of considerable distention.

The setæ are long and tubular and much coiled with the intestine, all being more or less bound together with tracheal threads, so that dissection is rendered somewhat difficult. On the whole the alimentary canal of the male seems to be as fully developed as that of the female. It may be mentioned as a point of importance in this connection that both sexes void quantities of fluid excrement from the

anus, as I have frequently observed, and which is very noticeable on the lower foliage and on the ground, under trees inhabited in some numbers by the cicadas. This discharge of fluid could not reasonably go on without the insect's taking food from time to time.

From the evidence in hand I am led to believe that both sexes of the periodical cicada normally take food in the usual sense of the word, and that in the case of young orchard trees, at least adjacent to woods, where the insects are likely to be abundant, injury may result to the plants attacked.

In discussing this paper Mr. Marlatt said that he wished to congratulate the author on having presented the first really thorough and careful observations which had ever been made on the feeding habits of the periodical cicada. Referring to the published statements in his Bulletin No. 14 on the feeding habits of these insects, he said that at the time this bulletin was written it was impossible to make field observations, and that most of the statements relating to food habits were drawn from general literature on the subject, but they included the reported observations of some of the best entomologists which this country has had, namely, Walsh, Riley, and Smith. In his own personal observations he had never noticed the cicada giving any special evidence of feeding. He was very glad that Mr. Quaintance had gone into the matter so fully, and felt convinced that it had been demonstrated that the cicada does normally and frequently, but perhaps not invariably, take liquid nourishment from trees and plants.

Mr. Smith thought that Mr. Marlatt was justified in his statements, and it was his opinion before hearing this paper that the digestive system of adults of the periodical cicada was rudimentary and not adapted to carrying off food stuffs. He had observed it feeding and had some twigs punctured for feeding purposes, but had often examined the digestive organs of both sexes and came to the conclusion that the cicada did not feed as a rule. Most of his examinations, however, had been made on specimens that had been dead for some time, and it was probable that the digestive organs had quite collapsed.

Mr. Quaintance stated that the intestine of the cicada was very small and thread like and was closely attached to the inner surface of the dorsum of the abdomen of the insect, and unless the dissections were carefully made, and under water, it would be readily overlooked.

Mr. Marlatt, in further discussion of the food of cicadas, said they fed quite industriously during the warm season of each of their seventeen years of underground life, and that it was, therefore, not unreasonable to suppose, in the absence of direct evidence to the contrary, that for the short period of their aerial life the nourishment previously gained would suffice, and hence the feeding in the adult stage might reasonably have been supposed to be a matter of chance. In his own obser-

vations he had never noticed the cicada feeding, and he thought it still open to question whether it was always necessary for the adult cicada to take food. That they did take food Mr. Quaintance had clearly shown. He doubted very much, however, whether the puncturing which they did to trees and the small amount of sap taken caused any special damage to the plant attacked. As an argument for the necessity of feeding of the periodical cicada might be mentioned the fact that when kept in confinement for a few days without food they invariably die.

Mr. Hopkins called attention in this connection to certain insects that can live a long time without food. Both the larvæ and adults of a clerid beetle, collected by him in Germany, had lived several months without food in little vials.

Mr. Quaintance queried if the feeding habits of adult cicadas might not possibly vary with different broods. He asked for information as to the relative abundance of the dwarf (*cassini*) variety.

Mr. Marlatt replied that he had had at different periods opportunity of witnessing three broods of the periodical cicada. In the first two of these he had failed to notice any of the smaller form, all of the specimens being of the normal large size. The present year fully 50 per cent of the early appearing individuals were of the small form. He had been informed also by Professor Galloway, who had made a trip through the West to St. Louis during the cicada prevalence, that the woods were filled with the deafening noise of a cicada, the song being entirely different from the ordinary one. From Professor Galloway's description the small cicada was undoubtedly the one heard, indicating its general abundance this year throughout the range of the brood.

Mr. Hopkins stated that in 1897 the small variety was very abundant in West Virginia, and that it came later than the others.

Mr. Quaintance remarked that the small form came after the large form had disappeared to a considerable extent in Washington County, Md.

The meeting then adjourned to reassemble at 2 p. m.

AFTERNOON SESSION, SATURDAY, JUNE 28, 1902.

The meeting was called to order by the president, who called for the report of the committee on membership. The committee reported as follows:

REPORT OF COMMITTEE ON MEMBERSHIP.

Your committee to consider the question of membership would report as follows:

We recommend the adoption of a by-law to the effect that it be the duty of the officers of the Association, each year previous to the annual meeting, to carefully examine the list of members and recommend to the Association the dropping of such

names as have in their opinion no further place upon our roll; such recommendations to be acted upon by the Association, and a vote of two-thirds of the members present to be sufficient to drop any name.

That in the interpretation of the paragraph of the constitution regarding the election of new members it be understood that an "economic entomologist" is a person who has been trained in entomological work and whose known work or published papers show him to be capable of conducting original work in economic entomology.

That the term "practical entomologist," referring to associate members, be held to indicate persons who have done general work in entomology and who have, by published papers or otherwise, given evidence of their attainments in such work.

That associate members be listed separately in the published roll or the fact that they are associate members be indicated in the list.

HERBERT OSBORN, *Chairman.*

JOHN B. SMITH.

E. P. FELT.

This report was unanimously adopted; and the report of the committee on resolutions was then read and adopted, as follows:

REPORT OF COMMITTEE ON RESOLUTIONS.

Whereas, the effect upon fruit trees of oil sprays for the San Jose scale has been very diverse in different States, and a study of the chemical composition of the petroleum oils used and their physiological effect upon fruit trees seems desirable: Therefore, be it

Resolved by the Association of Economic Entomologists, That the attention of the honorable Secretary of Agriculture be called to the desirability of the Department's undertaking a joint chemical, entomological, and physiological study of the problems involved.

Resolved, That we appreciate most fully the past favors of the Department of Agriculture in publishing the proceedings of this Association, and respectfully request that the proceedings of the present meeting be published as heretofore.

Resolved, That the thanks of the Association be tendered to Dr. W. J. Holland, and to the citizens of Pittsburg, whose favors have rendered the comforts and pleasures of the members in attendance at this meeting a feature to be remembered.

Resolved, That this Association has listened with great interest to the report of Mr. C. L. Marlatt's explorations in Japan and China to study the San Jose scale and its natural enemies, undertaken largely at his own expense; that we feel that the subject of applied entomology in America has been greatly developed and advanced thereby, and that we as an Association hereby tender to Mr. Marlatt our thanks for his generous and unselfish labors.

Respectfully submitted.

F. M. WEBSTER, *Chairman.*

HERBERT OSBORN.

W. E. RUMSEY.

REPORT OF COMMITTEE ON NOMINATIONS.

The committee on nomination of officers for the coming year reported as follows:

Dr. E. P. Felt, Albany, N. Y., president.

Mr. Wm. H. Ashmead, Washington, D. C., first vice-president.

Prof. Lawrence Bruner, Lincoln, Nebr., second vice-president.

Prof. A. L. Quaintance, College Park, Md., secretary and treasurer.

The report of the committee was unanimously accepted, and the secretary was instructed to cast the ballot for the Association.

The secretary presented the name of Mr. E. G. Titus as a candidate for membership in the Association. This name was proposed by Mr. Webster, who explained somewhat at length the training which Mr. Titus had had, the work he had done and his eligibility to membership. After some discussion by members Mr. Titus was elected to active membership.

There being no further business before the Association, the regular program was resumed:

NOTES FROM DELAWARE.

E. DWIGHT SANDERSON, *Newark, Del.*

At the last meeting of the entomological section of the Association of Agricultural Colleges and Experiment Stations the writer described the differences between the more common species of aphid affecting the apple and pear, and a further report concerning them will be found in the 13th report of the Delaware Agricultural Experiment Station, now in press. Our most common species, usually written *Aphis mali* Fitch, is entirely distinct from *A. mali* of Fabricius, which is a synonym of *A. pomi* De G., and the name *A. mali* must therefore be abandoned. I have consequently described Fitch's species as *Aphis fitchii* n. sp., in recognition of his very careful description of it. This name must be regarded as somewhat tentative, however, as Prof. Slingerland is of the opinion that *Aphis annua* Oestlund will probably prove to be the same species, in which case it would have priority, and there are certain European species which further study may show to be identical. Meantime the name *fitchii* will clearly designate the species discussed, and the confusion formerly existing will be obviated. This spring I again attempted to breed this aphid in the insectary upon wheat and various grasses, but seemed to fail entirely, none being observed to reproduce on them, either when inclosed in glass cylinders or when free. I also carefully examined a number of wheat fields and various pieces of grass at the time the aphides were migrating from the apples without finding them on the grass. Having found no aphides on the grasses in the insectary up to June 1, they were not examined again until June 25, when I found one of them well covered with an elongate yellowish-white aphid which had caused the leaves to wilt and become streaked with white. These aphides were decidedly elongate, with cornicles and cauda concolorous with body, cornicles tipped with black, antennae and eyes black, and sometimes with a greenish and sometimes a reddish splotch at the bases of the cornicles, but usually without such marking. A few pupae were observed but no winged females. It is possible that this may be the same species as the spring form on the apple, as it has certain "ear

marks," though in general it is entirely dissimilar. Should it prove to be the same, there must be a very enormous and decidedly remarkable mortality of the winged females migrating from the apple in May, for which there seems no good reason.

Aphis pomi DeG. seems more abundant than usual this year and becoming more widely distributed. It is unquestionably one of the worst insect pests of the young apple orchard and of old trees being top-worked, and how best to combat it is somewhat of a problem. It should be noted that some varieties of apples are decidedly preferred to others by the aphides, trees of another variety next to badly infested trees often remaining unmolested. Very frequently this season I have found colonies of this species of a bright orange-yellow color instead of the typical bright green, and also intermixed with the green forms. This striking variation has not been previously observed so far as recorded, and I regret that I have been unable to ascertain whether the yellow aphides reproduce the yellow form.

Owing to the manner in which they curl the leaves, *Aphis sorbi* and *pomi* are exceedingly difficult to combat; *Aphis fitchii* rarely does sufficient damage to warrant treatment. Washes of whale-oil soap, 2 pounds to a gallon of water, and lye 6 pounds to 50 gallons have both failed to destroy the eggs. Prof. Aldrich reports having killed the eggs with 33 per cent crude petroleum with water, using a heavy western oil of .954 specific gravity. We have sprayed several young trees with pure crude petroleum ("insecticide oil"), and though there seemed to be fewer young aphides on these trees, there were enough to soon stock the tree with lice. It seemed probable that the gummy residue left upon the surface of the bark was fatal to many of the newly hatched lice, as the crude oil had undoubtedly had a beneficial effect.

Fifteen per cent kerosene mixed with either water or Bordeaux mixture has not proven very satisfactory for destroying the aphides; 20 per cent kerosene seems more effectual and fairly satisfactory; 15 or 20 per cent crude petroleum is quite effectual and does no injury to the trees. When mixed with Bordeaux mixture it tends to make the latter collect in drops, and this is therefore an undesirable combination. Kerosene mixed with Bordeaux mixture and Paris green gives as even a coat upon the foliage as without the kerosene, and would seemingly form a perfect insecticide and fungicide where it can be used to advantage.

I am inclined to the view that in many cases the kerosene sprays are not effectual owing to the improper working of the pump. Kerosene emulsion made with soap and diluted to contain 15 per cent kerosene has failed to destroy the lice. Whale-oil soap, 1 pound to 6 and 8 gallons of water was ineffectual, though 1 pound to 7 gallons was fairly satisfactory. The latter is rather too strong, however, to use

on tender foliage. Rose-leaf insecticide, an extract of tobacco, one part to from 25 to 40 parts of water, is the most satisfactory spray we have used against these aphides. It is, however, most disagreeable to apply and rather too expensive for extensive use. Undoubtedly tobacco water made by boiling 1 pound of refuse tobacco in 1 gallon of water, with an equal amount of water added, will prove to be a good remedy, though we have been unable to give it a thorough trial.

The most satisfactory method of destroying these aphides on young trees is by fumigation. In 1899 we made several tests in fumigating them with hydrocyanic acid gas and found that they could be readily destroyed in ten or fifteen minutes. This spring we had a fumigator of the Geneva type constructed, covering it with strong muslin, which was thoroughly painted with thin glue, and it proved entirely satisfactory. This frame contained exactly 200 cubic feet. The aphides were entirely destroyed by burning 2 ounces of tobacco leaves and fumigating for fifteen minutes; also with one-half a roll of "aphis punk" for twenty minutes. A larger amount of the latter would probably be as effectual in a shorter time. "Aphis punk" is simply paper dipped in a tobacco extract, and is in a handy form to use, though rather expensive. Nikoteen and Nicoticide, both concentrated extracts of tobacco, were used very successfully by diluting with water and evaporating in shallow pans over an alcohol lamp furnished by the manufacturers. One and one-half cubic centimeters of Nikoteen diluted to 15 cubic centimeters with water killed the aphides in fifteen minutes, as did 4 cubic centimeters diluted to 15 cubic centimeters in eleven minutes. It requires about five minutes for the Nikoteen to evaporate. Five cubic centimeters of the Nicoticide diluted with 5 cubic centimeters water killed the aphides in ten and twelve minutes. The Nicoticide "is a very strong solution containing 40 per cent of nicotine" (quoted from a letter of manufacturers); it is a thinner and more volatile liquid than Nikoteen or Rose Leaf, evaporating over the lamp in about three minutes, and seems to be more rapid in its effect upon the aphides. We are inclined to regard this as the most satisfactory method of fighting these aphides upon young orchards. Usually but a few trees are infested here and there, and as the lice do not spread very much until the trees become overcrowded, by fumigating these few trees the injury can be almost entirely checked, as the fumigation destroys practically every aphid, whereas the best spray can not reach a very large percentage of those protected on the curled leaves.

A plain box or bell tent made of heavy, tight-woven muslin (we found a brand termed "Cast iron," in use by hot-air balloonists, very satisfactory) and painted with glue would be fully as satisfactory for use on small trees, and much cheaper. The materials for a tent should not cost over \$2, and the making is a simple matter. With a dozen

of these 2 or 3 men could get over a considerable number of young trees in a day.

The strawberry root-louse (Aphis forbesi).—Various means of destroying the strawberry root-louse upon plants prior to setting have been thoroughly tried. Sixty thousand plants were fumigated in two lots in a nurseryman's fumigation house for thirty and forty minutes with 0.2 gram KCN per cubic foot without injury to the plants, and the lice were killed as far as observed. The plants were laid loose, one or two layers deep, on frames of wire netting. Subsequently 7,000 were fumigated in several lots in a small box containing 10 cubic feet for thirty minutes with 0.2 gram KCN per cubic foot and 0.3 gram KCN for twenty-five minutes without injury to the plants.

From 20 to 75 per cent of plants dipped in whale-oil soap, 1 pound to 6 gallons of water, were killed, as were from 50 to 75 per cent of various lots dipped in kerosene emulsion diluted 10 times. Tobacco water (1 pound of stems boiled in 1 gallon of water, used undiluted) was this year used as a dip by a number of large growers with marked success. The beds of one party who has used it for several years showed its good effect. Plants dipped in Rose Leaf insecticide, 1 part to from 20 to 40 of water, were uninjured and the lice were killed. The main difficulty in fumigating or dipping prior to setting is that growers are desirous of setting early, and as with many insects a few of the eggs do not hatch until unusually late, dipping or fumigating at the time the growers wish to plant does not destroy these. To destroy the eggs we have tried burning over the beds, as the eggs are all upon the leaves as far as observed. By covering with straw or similar material which will make a quick fire and burning over just as the plants commence to grow in the spring, the foliage can be burned off without injury to the crowns and the plants will shoot out again, giving a good foliage by the time it is desired to set them in a new bed, and producing fruit the same as if unburnt, except perhaps being a trifle later. The burning should also be of value against other strawberry insects and diseases.

The codling moth.—In experiments with remedies for the codling moth in 1901 it was found that two bands on a tree caught 15 per cent of the larvæ infesting apples upon 5 trees, the percentage varying from 8 to 25 per cent, varying almost exactly inversely to the effectiveness of the spray used. Numerous larvæ and pupæ were collected from these bands, and it was found that a very large percentage hibernated over winter, there being, therefore, but a partial second brood.

Our chemist has kindly analyzed samples of two lots of arsenite of lime and one of arsenite of soda, made according to the usual formulas, with pure arsenic and boiled by steam, and in each case they contained but three-fourths the supposed amount of arsenious acid. The arsenite of lime was used last year at a strength equivalent to 1

pound of Paris green to 215 gallons of water, with a benefit of but 20 per cent over untreated trees for the whole season. It is believed that arsenites of lime or soda should be used at the rate of 1 pound or $1\frac{1}{2}$ pounds of AS_2O_3 to 160 gallons of water to be effectual, and they are being thoroughly tested at various strengths this year. Paris green, 1 pound to 160 gallons of water, and Disparene, an arsenate of lead, manufactured by Bowker Insecticide Company, 3 pounds to 150 gallons, were also tested upon 5 trees each, with 5 check trees, the dropped and picked apples being counted on all. One spraying of Disparene proved as effectual as two of Paris green. It will be noticed that the benefit derived is not so much in the smaller percentage of wormy picked fruit, though that is marked, as in the very much smaller percentage of wormy fruit dropped, the perfect fruit dropped being approximately the same for all the sprayed and unsprayed trees. With 60 per cent of the apples wormy upon the check trees, a benefit of 87 per cent for the season was secured by spraying twice with Disparene, of 60 per cent by spraying once, and of 61 per cent by spraying twice with Paris green. Of the dropped fruit, that sprayed with Disparene twice showed a benefit of 75 per cent, against 52 per cent with that sprayed with Disparene once and 54 per cent with that sprayed with Paris green twice. Likewise with the picked fruit, Disparene applied twice produced a benefit of 96 per cent, against 66 per cent when applied once and 69 per cent with Paris green applied twice.

The periodical cicada has been present the past month in northern Delaware, but so far as ascertained has not occurred in the two lower counties, and I have been unable to secure any records of its occurrence there in 1885. The pupæ first emerged in numbers on May 22, and continued except on a few cold nights until June 2, the most ascending on May 30. Several dogs and cats have been observed to relish the adult cicadas. The turrets or mounds of the pupæ were observed under pine and spruce trees on several old lawns and in a piece of pine timber burned over about the middle of May. The largest turrets were found under a small outbuilding, the floor of which was about a foot above the ground. Here the turrets completely covered the surface of the soil, reminding one of a house-top view over city chimneys, and were from 3 to 6 inches long.

The cicadas have been most abundant upon the lawns of several old estates around Newark, where in some cases they are more numerous than in 1885. The woods around Newark are now brown from dying twigs, and one or two young peach orchards have been practically ruined. The injury is only local, however, and not serious generally. It was observed that the pupæ upon emerging from the ground were strongly attracted by an acetylene bicycle lamp. On changing its position the pupæ would at once turn toward the light,

often going around a circle. Even their strong instinct for ascending the nearest tree was thus overcome, and in several instances those upon the base of the tree descended toward the light. Though I was unable to make a trial of it, this suggested that a bright light in the center of a sunken pan containing water and kerosene might make an efficient trap upon badly infested lawns.

During the season of 1901 the white-marked tussock moth and fall webworm were unusually injurious and seem to be almost equally so this year. The apple-tree tent caterpillar was more abundant this spring than for many years. Apples have been unusually injured by the plum curculio, eight or ten scars on an apple not being uncommon. Arsenical sprays seem to have no effect whatever in preventing this injury, apples being badly stung in an orchard which has been carefully sprayed for many years. On the same place, however, the fruit of an old cherry tree, which was formerly entirely destroyed by the curculio, is now untouched, owing to its being sprayed with arsenites and Bordeaux mixture.

Crambus caliginosellus continues to be one of our worst pests of young corn. *Systena tenuata* often destroys replanted corn and is our worst pest of newly set tomatoes, one for which we have as yet no very satisfactory remedy.

The strawberry weevil (*Anthonomus signatus*) was excessively injurious this year for the first time since 1898, and cut the early staminate varieties about one-third, and in some instances practically ruined the crop. A remedy for this pest would be of great value to berry growers, but it seems invulnerable to attack.

NOTES FOR THE YEAR IN NEW YORK.

By E. P. FELT, *Albany, N. Y.*

The season has not been marked by any unusual demonstrations by injurious insects, except in the case of a few species which will be noticed briefly.

The grape root-worm, *Fidia viticida* Walsh, has caused a great deal of injury in the Chautauqua grape belt during the last two years. It was estimated last spring that fully 80 acres had been practically destroyed by this insect and that at least 200 acres were more or less infested. Subsequent observations have shown that, in all probability, the infested area must be greatly extended. The insect has been so very injurious during the spring that certain vines which developed leaves in an apparently normal manner began to wilt about the middle of June and by the latter part of the month had died. This was attributed to the grape root-worm. The depredations appear to be more serious upon gravelly than upon heavy clay soil, and some recent experiments would appear to indicate that a considerable number of

the pupæ may be destroyed by plowing the soil away from the vines and back while the insect is in this stage.

The grapevine leaf-hopper, *Typhlocyba comae* var. *vitis*., has been exceedingly abundant and destructive in the Chautauqua grape belt last year and early this spring. It caused a great deal of injury in the fall of 1901, and present conditions are very threatening. This insect is now being investigated by Professor Slingerland of Cornell University.

The apple-tree tent caterpillar, *Clisiocampa americana* Fabr., has been conspicuous by its absence in certain portions of western New York. This is probably due, in some cases at least, to the very heavy snows of the preceding winter, which allowed mice free access to all roadside trees and shrubs, which were very largely girdled by these mischievous rodents. It thus happened that the tent caterpillars found very little of their favorite food and undoubtedly many hatching on these unfortunate trees must have perished.

The forest tent caterpillar, *Clisiocampa disstria* Hubn., has been present in comparatively small numbers and its depredations during the last three or four years appear to be on the decrease. It is hoped that this year will see the end, for a time at least, of serious injuries by this pest.

The fall webworm, *Hyphantria cunea* Drury, has appeared in the State unusually early and indications are that it will be more destructive than usual.

OBSERVATIONS ON CERTAIN INSECTS ATTACKING PINE TREES.

By E. P. FELT, *Albany, N. Y.*

The work of several species of *Tomicus* has been very apparent in the Hudson River Valley during the last two or three years, and at our last meeting the writer placed on record his belief that species belonging to this genus were responsible for the destruction of many white pines in New York State. More extended observations have but strengthened that opinion, and this paper is really a continuation of the one published on pages 63-68 of our last proceedings.

One pine was found which bore no signs of injury, although its branches were sparse, which had been entered in large numbers by *Tomicus calligraphus* Germ. The needles were rather thin August 5, 1901, but practically none were brown, although pitch tubes were very abundant and many small masses of pitch had dropped upon the foliage of surrounding shrubs. At this time most of the beetles were running their primary galleries in the living bark along practically the entire length of the trunk and many eggs were being laid.

The next observation was made September 26, and then two-thirds of the needles were brown and the remainder were changing rapidly.

October 16 practically all the needles were brown and dead. The bark was entirely dead, moist, and its inner layers consisted of little else but decaying borings. Practically all of the living Tomicids had forsaken this tree, though some were found in one near by which had been less severely injured. The limbs were entirely bare of needles early in this spring.

This rapid destruction is also well shown in two other trees of which the writer possesses photographs. These pines had been under general observation for four or five years, and early in 1901 the foliage of the top of one may have been a little thinner than normal. This was noticed in particular August 5, at which time the lower limbs were nice and green, though the upper portion of the tree was then dead. An examination showed that the latter had been attacked by *Tomicus pini* Say. The work of *Tomicus calligraphus* in the living lower portion of the trunk was very evident at this time. *Monohammus confusor* Kirby was also very abundant about this tree. It had evidently bred in considerable numbers in the upper portion of the trunk and then attacked the lower part. The needles had practically all fallen from the upper limbs September 26, and those on the lower were brown and dead. Early in 1902 nothing but bare limbs remained. The companion in misfortune stood close by, and August 5, 1901, bore many pitch tubes above the middle, the work of *Tomicus calligraphus*. September 26 all its needles were browning fast, especially those of the lower limbs, and all were dead October 16. Its condition early in 1902 was the same as that of the trees described above. Both of the last mentioned had been attacked by *Dendroctonus terebrans* Oliv., but in small numbers, and most of the injury was undoubtedly caused by Tomicids.

The destructive work of *Tomicus pini* was further evidenced by a complaint from Jeremiah Day, of Catskill, N. Y., December, 1901, to the effect that 50 young white pines 25 or 30 years old had been killed during the preceding summer, and specimens of bark proved this species to have been the depredator.

The above shows how quickly a tree may die and lose its foliage in the Northern States. The dates given above indicate that a pine may be destroyed in about ten weeks. The rapidity with which such trees yield to the elements is well shown in this photograph, which represents a tree that was probably attacked early in 1900, because September 15, 1900, it was in a dying condition. *Tomicus calligraphus* was present in immense numbers at the base of the trunk and in smaller numbers higher up. *Tomicus pini* was found in the lower middle part of the trunk, in the upper portion, and also on the undersides of the limbs. It was found almost exclusively wherever the bark was too thin for the larger form.

The pines along the Hudson River Valley have suffered severely

from these bark borers, which apparently have been the primary cause of the trouble. The reason for this outbreak is not known, although it possibly may have some connection with the great drought of the preceding years, which may have weakened the pines and rendered them easier victims of their insect enemies.

EGG-LAYING RECORD OF THE PLUM CURCULIO.

(*Conotrachelus nemuphar* Herbst.)

By A. L. QUAINANCE and RALPH I. SMITH, *College Park, Md.*

The accompanying table requires but little in the way of explanation, aside from a statement of conditions under which the work was done.

On the morning of May 13, 1902, a considerable number of curculio were caught from Japan plum trees in the college orchard, by the usual jarring method. At this time egg laying had but just begun, as very few punctures were to be found in the young plums. Ten females were taken in copulation and each placed in a four-ounce bottle. Three or four fresh plums were supplied daily to each insect, and the number of eggs deposited was determined by dissection of punctures in the plums as removed. It was found necessary to examine each puncture carefully, as a considerable number of punctures and crescents were to be found in which no eggs were deposited. The bottles were kept rather loosely corked and bits of filter paper were placed in bottom of bottle to absorb any surplus moisture from the plums.

A review of the table shows that the greatest number of eggs deposited by any one beetle was 436, in the case of No. 5, with 276 as the minimum for No. 1, of practically the same age. It is also to be noted that the egg-laying period lasted for eighty days. The death of beetles Nos. 1, 5, and 9, about August 1, would indicate that females may live approximately twelve months and that the broods would overlap somewhat.

Table showing egg-laying record of the plum curculio (Conotrachelus nemuphar), 1902.

Date.	Curculio—									
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.	No. 10.
1902.										
May 14.....	2	4	0	9	8	7	0	3	8	4
15.....	0	10	0	3	4	5	0	3	1	10
16.....	8	6	0	9	12	12	2	10	13	9
17.....	7	9	0	9	12	9	0	3	10	9
18.....	6	12	0	9	10	10	3	6	9	13
19.....	5	12	0	8	9	11	3	7	8	13
20.....	9	12	0	15	15	10	9	13	16	13
21.....	15	9	0	17	17	11	8	11	16	13

Table showing egg-laying record of the plum curculio, etc.—Continued.

Date.	Curculio.—									
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.	No. 10.
1902.										
May 22	9	12	Male?	15	13	14	9	13	17	No p.
23	9	13	.....	14	11	10	8	8	12	14
24	11	15	.....	17	15	13	12	12	14	14
25	9	15	.....	13	17	5	1	13	18	12
26	8	15	.....	14	18	4	4	12	18	11
27	14	12	.....	12	13	10	0	14	19	15
28	3	5	.....	8	8	6	Died.	4	6	12
29	6	4	.....	6	7	4	.....	7	7	8
30	5	3	.....	6	5	5	.....	3	6	5
31	6	6	.....	8	10	5	.....	(a)	9	10
June 1	7	8	.....	9	11	11	.....	.....	11	14
2	7	9	.....	9	11	10	.....	.....	11	14
3	9	5	.....	13	12	15	.....	.....	11	14
4	0	5	.....	7	8	11	.....	.....	12	12
5	6	0	.....	9	9	7	.....	.....	12	8
6	0	4	.....	6	4	6	.....	.....	6	2
7	4	5	.....	10	7	7	.....	.....	10	5
8	4	5	.....	7	5	7	.....	.....	6	4
9	4	4	.....	8	5	7	.....	.....	7	4
10	2	3	.....	4	7	6	.....	.....	7	1
11	2	1	.....	6	4	4	.....	.....	8	4
12	5	3	.....	2	7	3	.....	.....	8	1
13	5	5	.....	4	6	4	.....	.....	8	3
14	0	2	.....	2	4	5	.....	.....	4	5
15	4	0	.....	6	4	4	.....	.....	4	5
16	4	0	.....	6	3	4	.....	.....	4	5
17	4	0	.....	2	8	3	.....	.....	3	4
18	3	0	.....	2	5	2	.....	.....	3	4
19	2	2	.....	Died.	3	3	.....	.....	3	7
20	2	Died.	.....	.....	3	0	.....	.....	5	4
21	2	.....	.....	.....	4	0	.....	.....	3	3
22	2	.....	.....	.....	3	0	.....	.....	4	2
23	1	.....	.....	.....	3	0	.....	.....	1	2
24	2	.....	.....	.....	4	0	.....	.....	3	3
25	2	.....	.....	.....	2	0	.....	.....	3	0
26	1	.....	.....	.....	1	0	.....	.....	2	0
27	3	.....	.....	.....	0	0	.....	.....	0	1
28	2	.....	.....	.....	2	0	.....	.....	1	0
29	4	.....	.....	.....	5	0	.....	.....	1	3
30	1	.....	.....	.....	2	0	.....	.....	1	4
July 1	1	.....	.....	.....	2	0	.....	.....	2	0
2	2	.....	.....	.....	3	0	.....	.....	2	0
3	1	.....	.....	.....	1	0	.....	.....	0	0
4	1	.....	.....	.....	1	0	.....	.....	2	0
5	1	.....	.....	.....	2	0	.....	.....	2	0
6	1	.....	.....	.....	2	0	.....	.....	0	0
7	0	.....	.....	.....	0	0	.....	.....	1	0
8	0	.....	.....	.....	0	0	.....	.....	1	0
9	0	.....	.....	.....	0	0	.....	.....	0	0
10	0	.....	.....	.....	0	Died.	.....	.....	0	0
11	0	.....	.....	.....	0	.....	.....	.....	0	0
12	1	.....	.....	.....	1	.....	.....	.....	0	0
13	1	.....	.....	.....	2	.....	.....	.....	0	1

a Escaped.

Table showing egg-laying record of the plum curculio, etc.—Continued.

Date.	Curculio—									
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.	No. 10.
1902.										
July 14	1				2				0	1
15	0				1				0	1
16	1				3				0	3
17	1				2				0	1
18	1				1				1	2
19	1				1				0	1
20	1				4				1	2
21	2				5				2	3
22	3				4				1	1
23	2				4				2	2
24	4				3				1	4
25	3				4				2	4
26	4				5				3	Died.
27	3				5				1	
28	3				5				1	
29	2				4				0	
30	2				4				0	
31	1				4				Died.	
Aug. 1	3				5					
2	Died.				Died.					
Total	276	235		294	436	270	62	142	396	348

The following papers, which had been sent to the secretary, were read by title:

NOTES FROM NEW MEXICO AND ARIZONA.

By T. D. A. COCKERELL, *East Las Vegas, N. Mex.*

Nothing especially remarkable has occurred in the field of economic entomology during the past year or two in this part of the country, but the following records are not without interest.

COCCIDÆ.

Parlatoria blanchardi (Targ.).—Professor Forbes (Johnson, Fumigation Methods, p. 229) has recorded the fumigation of about 400 date-palm suckers infested with *Parlatoria*. He determined, experimentally, that palms would stand a strong dose, and accordingly treated all those received at Tempe, Ariz., for the date-palm orchard of the Arizona experiment station. In the spring of the present year I inspected all these palms and found that the *Parlatoria* had been totally destroyed. Of course, there are parts of the palms which can not be examined without pulling them to pieces, but I feel quite sure that the *Parlatoria* would be in evidence upon the visible parts by this time if any had survived. On one palm I found a small quantity of *Phenicococcus marlattii*, Ckll., alive and healthy.

APHIDIDÆ.

Chaitophorus negundinis Thomas, on box-elder, and *C. populicola*, Thomas, on narrow-leaved cottonwood, are common in Las Vegas, N. Mex.

LEPIDOPTERA.

Glisiocampa constricta Stretch.—The larvæ of this species defoliated great numbers of cottonwood at Tempe and Phoenix, Ariz., in March, 1902. They were full fed, spinning up at the end of March, and I noticed that they often wandered 100 yards or more from the trees. It would doubtless be easy to trap them at this time with gunny sacks tied around the trees. I bred several moths, but got no parasites. The larva is quite variable in its markings. I made the following notes at Tempe, March 29:

Larva, wandering, ready to pupate; 38^{mm} long (smaller ones, perhaps males, 27^{mm}); general color the usual light blue-gray, with long, white hairs, those on dorsum about 5^{mm}; a broad black dorsal band, constricted somewhat at the sutures, on each segment bearing many erect, rather short, orange-ferruginous hairs; sides minutely speckled with black; an elongated irregular subdorsal black mark on each side of each segment, its lower edge bordered by a small, pale mark; extreme sides with denser tufts of white hair; under surface black, clouded with gray; abdominal legs pale ferruginous apically; head spotted with black and beset with erect, black hairs. Other specimens have large more or less dumb-bell shaped orange dorsal patches, one on each segment.

COLEOPTERA.

Galerucella decora var. *salicis* Randall (det. Schwarz.), was found May 24, 1902, injuring willow in Gallinas Canyon, New Mexico, at a place called Trout Spring.

Lina scripta Fab., was found this year in Las Vegas, N. Mex., but it is rare and not destructive with us. Probably it has some natural enemy to keep it down.

Anthrenus scrophulariæ Linn. has been abundant this spring on flowers in Las Vegas. The first specimens were found by Miss Florence Mair, on flowers of cultivated Berberis.

Haltica foliacea Lec. (det. Fall), was found at the top of the Las Vegas Range, New Mexico, at about 11,000 feet, at the end of June, 1901. What could be its food plant at this altitude? *Epilobium*, perhaps.

Chrysobothris mali Horn. (det. Schwarz.), was received from Simmons, Ariz., where it was reported to have killed a two-year-old apple tree. The species was originally found infesting apple trees in California, but it has occurred also on native trees and shrubs (though not bred therefrom) and is presumably native. See Fall, Coleop. So. Calif. (1901), p. 117.

Diabrotica 12-punctata Oliv., occurs at Phoenix, Ariz., and is not

replaced by *D. soror* until we reach California. From San Bernardino westward *soror* takes its place completely.

A PARTIAL LIST OF THE COCCIDÆ OF OHIO.

By F. M. WEBSTER and A. F. BURGESS, Wooster, Ohio.

In connection with the following list a short explanation is not inappropriate. The supervision of the work of nursery and orchard inspection was placed in the hands of Mr. Webster in 1900, and the original intention was to gradually collect as much data as possible while carrying out the work and later to publish a report that would be of service to the people and at the same time contain matter of value to the science of entomology. With the retirement of the board of control and the resignation of Mr. Webster, as well as the placing of the inspection work in the hands of the State board of agriculture, the original project had to be abandoned. But we have thought that the fragments obtained during this time were worth placing on record and whatever of value they might possess made available to other entomologists in Ohio or elsewhere. We do not present this as a complete list of the Coccidæ of Ohio, by any means, but rather as the possible basis for a better one, and which will, beyond a doubt, be the work of others than ourselves.

We are greatly indebted to Mr. George W. King and Prof. T. D. A. Cockerell, who made most of the determinations for us at the expense of much time and labor, and without their aid we should hardly have attempted the list at all. Dr. Howard and his assistants have also aided in the same manner. We have also included such species as were contained in Prof. Herbert Osborn's list, included in his "Remarks on the Hemipterous fauna of Ohio with a preliminary record of species" (Eighth Annual Report of the Ohio State Academy of Science, pp. 60-79, 1900), and also species collected by Professor Osborn's assistant, Mr. J. G. Sanders.

1. *Eriococcus azaleæ* Comst. On *Rhododendron catawbiense*, Wooster, May 29, 1900 (Webster). This shrub was planted on north side of experiment station building, and the insect had withstood winter weather in the open.
2. *Gossyparia ulmi* Geoff. On elm, Columbus, June 4, 1902 (Burgess).
3. *Phenacoccus osborni* J. G. Sanders..... On *Platanus occidentalis*, Columbus (J. G. Sanders).
4. *Phenacoccus aceris* Sign. On maple, New Philadelphia, July 13, 1900; Springfield, Oct. 3, 1901.
5. *Dactylopius citri* Bois. Common in greenhouses.
6. *Dactylopius adonidum* Linn. On roots of plum and Carolina poplar in insectary (C. W. Mally); feeding in insectary on canna, barberry, rose, onion, tobacco, and poplar (Wilmon Newell).
7. *Dactylopius longispinus* Targ. In greenhouses.

8. *Kermes gallifornis* Riley..... On oak, Wooster, Sept. 29, 1899 (Wilmon Newell); see also American Naturalist, XV, p. 482, 1881.
9. *Kermes trinitatus* Bogue..... On white oak, Georgesville (J. S. Hine).
10. *Orthezia americana* Walk. (?)..... Georgesville (Fullmer). 8th Rep. Ohio State Academy of Science, p. 71.
11. *Orthezia insignis* Dougl. Wooster; Columbus (Osborn). Common in greenhouses.
12. *Lecaniodiaspis celtidis* Ckll. Sandusky (Osborn). Given in Rep. Ohio State Acad. Sci. Rep., p. 71, as a Lecanium.
13. *Asterolecanium variolosum* Ckll. On *Quercus aurea*, Mentor, Feb. 7, 1900 (Wilmon Newell).
14. *Pulvinaria innumerabilis* Rath. Common and sometimes injuriously abundant on maple; Wooster, July 2, 1901, on elm (Burgess); Shreve, July 5, 1901, on pear (Burgess).^a
15. *Pulvinaria acericola* W. and R. Cleveland, July 11, 1901, on maple. Columbus (Osborn).
16. *Eulecanium armeniacum* Craw On Spanish chestnut, Painesville, Feb. 5, 1897 (Webster), on plum, Richland, June 28, 1900; on plum, Bowling Green; peach, Mentor (Burgess).
17. *Lecanium caryæ* Fitch..... On American elm, Wooster, June 4, 1902 (R. L. Webster).
18. *Lecanium fletcheri* Ckll. On *Thuja occidentalis*, Columbus, Feb. 27, 1902 (Sanders).
19. *Eulecanium oleæ* Bern. Columbus (Osborn).
20. *Eulecanium cockerelli* Hunter Lakeside, on peach, Dec. 1, 1900, and Shreve, on pear, July, 1901 (Burgess).
21. *Eulecanium fitchii* Sign. On blackberry, Minerva; premises of H. H. Altfather.
22. *Eulecanium canadense* Ckll. On American elm, Wooster, July 2, 1901 (Burgess).
23. *Eulecanium websteri* King On mulberry, southern Ohio (Webster).
24. *Eulecanium tulipiferæ* Cook..... On tulip trees, Wooster (Webster); on tulip trees, Cincinnati (Burgess); on same, Avondale (R. W. Braucher); on tulip tree, Lodi, Aug. 1, 1900; on tulip tree, Painesville, July 17, 1901 (Burgess); Warren, July 10, 1901; Weston, Sept. 19, 1898 (Webster).
25. *Eulecanium magnoliarum* Ckll. On magnolia, Cincinnati (R. W. Braucher), Feb. 19, 1901.
26. *Eulecanium nigrofasciatum* Perg. Wooster, Mar. 26, 1902 (R. L. Webster); Cleveland, Dec. 24, 1899, on Norway maple (Webster); Mansfield; Wells-ville, Mar. 21, 1901.
27. *Eulecanium nigrum* var. *depressum* On California pepper tree, Cleveland, Targ. Feb. 6, 1900 (Newell).

^aYoung, probably of this species, were found on Virginia creeper, at Mentor, Nov. 2, 1901, by J. C. Britton. Immature specimens from maple, resembling a Lecanium but having the antennæ of a Pulvinaria, may, perhaps, prove to be a new species.

28. *Eulecanium persicæ* Fabr. Syracuse (Osborn); Dresden (Webster); Norwalk, May 21, 1900, on nectarine.
29. *Eulecanium quercifex* Fitch..... On oak, College Hill, May 22, 1900 (Webster).
30. *Eulecanium prunastri* Fonsc. On plum, very abundant at Gypsum, 1900 (Webster).^a
31. *Calymnatus hesperidum* Linn. Wooster, in greenhouses on lemon, fig, cinnamon cassia (Webster); oleander.
32. *Saissetia hemisphæricum* Targ. Wooster, insectary, on chrysanthemum, Sept. 17, 1897 (Webster); on *Pteris* sp? Jan. 1, 1900 (Newell); on *Cryptomium balsatum* (Webster); Ashland, Mar. 10, 1897.
33. *Aspidiotus hederæ* var *nerii* Bouché... On yucca, Cleveland, Feb. 6, 1900; Cincinnati, Feb. 13, 1901, on palm; on oleander, Dayton, Aug. 12, 1901 (H. E. Maxwell); Columbus (Osborn).
34. *Aspidiotus juglans-regiæ* Coms. On maple, Kinsey, Aug. 4, 1900 (Hine).
35. *Aspidiotus ostryæformis* Curtis..... On plum, Danbury, Dec. 13, 1900 (Burgess); on snowball, linden, and ornamental maple, Cincinnati, Mar., 1901 (R. W. Braucher); on Carolina poplar, Cleveland, Apr. 4, 1901 (Webster); Massilon, Aug. 2, 1901 (Newell).
36. *Aspidiotus rapax* Comst. On bay tree, greenhouses, Soldiers' Home, Dayton, Aug. 18, 1901 (Burgess).
37. *Aspidiotus perniciosus* Comst. On all kinds of fruit trees except sour cherry; also on currants, gooseberries, strawberries, grapes, raspberry, blackberry, elm, maple (rarely), poplar, willow, catalpa, etc. There are over 125 infested localities known in the State.
38. *Aspidiotus aurantii* Maskell On orange tree, June 30, 1902, Columbus (J. G. Sanders).
39. *Aspidiotus ancylus* Putn. On currant, Bridgeport, 1895 (Webster) Clyde, Jan. 18, 1897; on *Cornus variegatus*, Cleveland, Feb. 7, 1900; on *Clethra alnifolia*, Painesville, July 17, 1900 (Burgess); on Norway maple, Perry, July 19, 1900 (Burgess); on quince, Lakeside, Nov. 15, 1900 (Burgess); on plum, Danbury, Dec. 1, 1900 (Burgess); on maple, New Antioch, Mar. 25, 1901. Occurs also on apple and peach, seldom in injurious numbers, and is general over the State.^b

^a *Eulecanium* species not determinable from material at hand are as follows: On rose, Rumley; on peach, Lakeside (Burgess); on Osage orange, Lakeside (Burgess); on pear (George W. Gill), Columbus; on apple, Mentor (Burgess); on plum, Lakeside (Burgess); on quince, Lakeside. What is likely *E. pyri* Schr. was found at Shreve, July 5, 1901 (Burgess), but this should be verified.

^b *Aspidiotus perniciosus* and *Mytilaspis ulmi* Linn. have been sent me intermixed on twigs of an unknown shrub, from Sandy Bay, near Hobart, Tasmania, by Mr. Horace Watson.—F. M. W.

40. *Aspidiotus forbesi* Johns. On currant, Mertz, Apr. 12, 1896 (Webster); Frogys, Mar. 9, 1898, on cherry; on apple, Painsville, Aug. 22, 1900, (Burgess); on walnut, (J. C. Britton); Columbus (Osborn); Mentor, Cheshire, and elsewhere throughout the State, on cherry and old apple trees.
41. *Aspidiotus cyanophylli* Sign. On *Pritchardia filifera* in greenhouse, Columbus (J. G. Sanders).
42. *Aspidiotus obscurus* Comst. On oak, Catawba Island (W. H. Owen); on hickory, Danbury, Dec. 20, 1900; Columbus (J. S. Hine).
43. *Aspidiotus comstocki* Johnson. On maple, Columbus. See Bull. No. 6, N. S., U. S. Dept. Agr., p. 76 (W. G. Johnson).
44. *Aspidiotus uvæ* Comst. On grapes, Cincinnati, Feb. 15, 1901 (Burgess); Pomeroy, Apr. 15, 1901; also on grape.
45. *Aspidiotus ficus* Ashm. In greenhouses, Wooster (Webster); Columbus, in greenhouses (Osborn).
46. *Aspidiotus glanduliferus* Ckll. On *Pinus sylvestris*, Columbus (J. G. Sanders).
47. *Aspidiotus crawii* Ckll. On *Salania* sp.? McGregor's greenhouses, Springfield, Feb. 15, 1900.
48. *Chrysomphalus dictyospermi* Morg. Columbus (Osborn).
49. *Chrysomphalus aonidum* Linn. Reported from Ohio by Mr. Geo. B. King.
50. *Diaspis pentagona* Targ. Painsville, introduced on double flowering cherry from Japan. Died out during winter of 1898-99 (Webster).
51. *Diaspis cacti* Comst. In greenhouses, Columbus (Osborn).
52. *Diaspis boisduvalii* Sign. On palm, Wooster, station greenhouse (Webster); on *Serfortia* sp.? Cincinnati, Eden Park conservatories, Feb. 19, 1900 (Newell); on palm, Columbus (Hine).
53. *Aulacaspis rosæ* Bouché. On rose, raspberry, blackberry, common, Wooster, Columbus, Mentor, New Carlisle, Berlin Crossroads, New Antioch, Perry, Portsmouth, Eaton, Cleveland, Toledo, Xenia, Fruit Hill, Cincinnati.
54. *Aulacaspis bromeliæ* Kerner Columbus (E. E. Bogue).
55. *Parlatoria pergandei* Comst. On Croton, Painsville, Sept. 22, 1900 (Webster); Columbus (Osborn).
56. *Parlatoria zizyphus* Lucas On oranges in market, Columbus (Sanders).
57. *Mytilaspis linearis* Mod. Reported from Ohio by Mr. Geo. B. King.
58. *Mytilaspis pomorum* Bouché Abundant and destructive, especially in the northern parts of the State. Seems to be increasing in abundance and severity of injuries, especially on apple, Carolina and Lombardy poplars, willows, and lilac.
59. *Mytilaspis citricola* Pack. On oranges in the markets. Not known as established in the State, in conservatories, and greenhouses.

60. *Mytilaspis ulmi* Linn. On maple, Dayton, Aug. 19, 1901 (Burgess). Received from Sandy Bay, Tasmania, on apple (Webster).
61. *Chionaspis biclavis* Comst. Columbus (Osborn).
62. *Chionaspis euonymi* Comst. On althea sp? Spring Hill Cemetery, Cincinnati, Feb. 13, 1901 (Burgess).
63. *Chionaspis furfurus* Fitch Generally distributed over Ohio on apple, pear, quince, and currant.
64. *Chionaspis pinifoliae* Fitch On *Pinus austriaca*, generally over the State where this pine is grown.
65. *Chionaspis corni* Cooley Sandusky (Osborn).
66. *Chionaspis salicis-nigræ* Walsh Not uncommon on willow; Wooster, June 14, 1901 (Burgess); West Carlisle, Oct. 4, 1901, on poplar (Burgess.)
67. *Chionaspis americana* Johns. On *Ulmus americanus*, Columbus, Feb. 28, 1902 (J. G. Sanders).
68. *Chionaspis ortholobis* Comst. On *Gleditsia triacanthos*, Columbus, Jan. 21, 1902 (Sanders).
69. *Howardia biclavis* Comst. On *Hibiscus aculeatus*, Columbus (Sanders).
70. *Kermes andrei* King On *Quercus prinus*, Columbus, May 30, 1902 (J. G. Sanders).
71. *Kermes pubescens* Bogue. On *Quercus macrocarpa*, Columbus, June 18, 1902 (J. G. Sanders).

OBSERVATIONS UPON THE MOSQUITO, CONCHYLIASTES MUSICUS.

H. A. MORGAN, *Baton Rouge, La.*

Along the creek bottoms of the uplands of Louisiana this mosquito is not uncommon, and in these regions is frequently called the "swamp mosquito," a name which is misleading, for in alluvial marshes and swamps it is seldom seen. The female is fierce in its attack upon mammals frequenting wooded regions in the vicinity of creeks. Marked swellings usually follow the attack upon man.

Nothing has been published relative to the life history of this mosquito. In fact, we are not aware of any observations upon the stages of its development save in the adult.

Dr. J. W. Dupree, of the city of Baton Rouge, captured April 30, 1902, a female which he permitted to feed upon his hand until fully engorged. On the morning of May 1, 40 eggs were found, some at the bottom of the glass containing the water, while others were resting upon some fibers of cotton which had accidentally fallen into the vessel. Dr. Dupree thinks it altogether likely that the eggs, which are deposited singly, under normal conditions rest upon floating débris. The eggs resemble somewhat in shape those of *Stegomyia fasciata*, though larger. Short spines pointing toward the so-called head of the egg are uniformly distributed over the entire shell. The egg has a flat and a convex surface, and with the latter uppermost presents a distinctly fusiform shape. Unless débris or a strong film floats upon the

surface of the water, all the eggs sink to the bottom of the vessel, which accounts no doubt for the irregular periods of incubation. Of the 40 eggs deposited during the night of April 30 a few hatched on May 15, others hatched on May 30, and still others of the same brood on June 10. It will be seen from this that a wide range obtains as to the incubation period (from fifteen to forty days).

The larvæ are active at the surface of the water for the first twenty-four hours, after which they move to the bottom when disturbed, and can there remain as long as forty-seven minutes without coming to

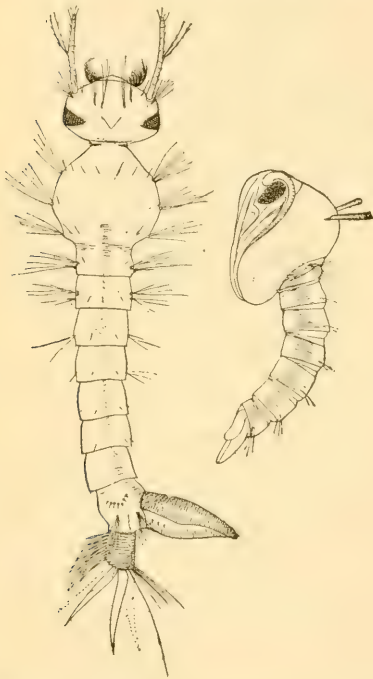


FIG. 1.—*Conchyliastes musicus*: egg, at left; larva, in middle; pupa, at right; all enlarged (drawn in Division of Entomology).

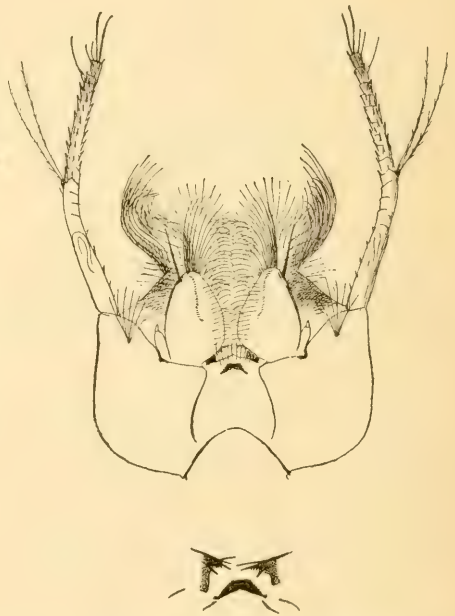


FIG. 2.—*Conchyliastes musicus*: head of larva above; inner mouth-parts of larva below; much enlarged (drawn in Division of Entomology).

the surface for air. Larval growth is very rapid, most of the specimens bred reaching the pupa condition in five days (120 hours), though as long as seven days have been spent in this condition.

The larvæ are not “wrigglers” in the true sense of the term. They jerk characteristically when suddenly disturbed, but ordinarily move from the top to the bottom of the vessel at an angle of about 45 degrees with little motion save the rapid movement of the oral cilia. The passing of the larvæ from the top to the bottom of the water with apparently little effort gives them a graceful appearance. While at the bottom of the glass they catch large bundles of *Spirogyra*, which are broken into smaller pieces as the surface is approached. The verticles

caused by the movement of the oral cilia bring the small pieces of food to the mouth. The pupæ are extremely sensitive, shifting position from the surface of the water with the slightest irritation. Length of pupal stage, twenty-four hours.

The peculiar conditions best suited for the development of this species of mosquito have not yet been found. Females fed in confinement upon the blood of mammals in most cases died in a few days without depositing eggs. Eggs procured in two instances were from females which were engorged with blood a few hours before oviposition.

To Dr. J. W. Dupree is due the credit for the information contained in the above article.

SOME NOTABLE INSECT OCCURRENCES IN OHIO FOR FIRST HALF OF 1902.

By HERBERT OSBORN, *Columbus, Ohio.*

The season is not far enough advanced to enable us to say what its character as a whole may be from the entomological standpoint, but already there have been several species appearing in such numbers as to attract more than usual attention.

The clover leaf-weevil, *Phytonomus punctatus*, has been unusually plentiful, and during the middle of May the larvæ were to be found in large numbers on the university farm. This is, I believe, the first time that this species has been destructively abundant in this locality. Its work will therefore be watched with interest, and it is to be hoped that it will repeat its usual history of being destructive for but one or two seasons.

The chinch bugs were flying in large numbers during the month of May, being especially conspicuous from the 15th to 20th. This abundance was to be looked for, as they were very plentiful last autumn and the winter was fairly favorable for their hibernation. Some reports of destructive work in wheat have been received, but since the heavy rains of early June these have been fewer, and there is perhaps no very serious outlook at present writing for the remainder of the season.

The cankerworm continues to be a menace to the orchards, and in many a very serious loss has occurred. There are a number of places near Columbus where this insect is defoliating the trees each spring; and while its work is much commented on at the time destruction is in progress, there seems a decided apathy on the part of a good many of the orchardists with regard to suppressing their onslaughts. In a number of places I have noticed their work also on elms, and the increase and spread of the species certainly merit all the attention they have received and a little more of vigorous treatment on the part of owners of orchards and timber plantations.

The horn fly, *Hæmatobia serrata*, has been noticed as very plentiful, perhaps not so abundant as during one or two summers after its first distribution, but in such numbers as to prove a serious annoyance to animals.

The fall webworm, *Hyphantria cunea*, has appeared in very great abundance and, it seems to me, much earlier in the season than usual. One colony was noticed in the latter part of May with larvæ already nearly grown, and during June numerous broods have been observed, some of which at present, June 26, appear to have completed their growth and entered the pupa stage. I have noticed the cuckoo feeding on the larvæ, tearing open the webs in order to get at them.

The occurrence which has doubtless attracted the most general attention and received the most extended popular notice is that of the periodical cicada, the eastern border of the brood passing just east of the city of Columbus.

The first occurrences noted in this locality were May 20, while reports indicated it two or three days earlier at Cincinnati. There seemed to be a fairly well marked early and later wave in appearance separated by a period of about two weeks, a second very abundant occurrence coming in early June. In an old orchard on the university campus this was particularly marked, as the early ones seemed to be completely destroyed by the attacks of the English sparrow so that at one time, about June 1, no individuals could be seen or heard, while the ground was completely littered with the wings and other fragments of the dismembered cicadas. The later appearing forms, while not so completely destroyed at that point, were, I think, mostly destroyed before they had succeeded in laying eggs, and for this particular spot it would appear as if there would be scarcely any to appear in another seventeen years. To some extent this is true of the wooded tracts near the city, but a few miles out I have noticed that the timber is pretty well marked with wilting leaves or drooping twigs which indicate the deposition of eggs.

A very noticeable feature, especially striking to me since I have never encountered it so conspicuously before, is the very large proportion of the small form of the cicada which has been recognized under the name of *cassini*. I have improved the opportunity to secure measurements of a large series, but this forms the subject of another paper and need not be further mentioned here.

An interesting occurrence noted this spring is *Gossyparia ulmi*, not hitherto recorded for Ohio, but found in sufficient numbers to be worthy of mention. As yet it can hardly be counted as of destructive abundance, but, taken with other coccids on the same tree, it must cause some injury.

A *Pulvinaria* has been observed as quite abundant on elms also, but lack of time has prevented any careful study of it.

Following the reading of these papers, they were opened for discussion.

Mr. Fisher asked how the cankerworm was most successfully treated. He stated that there was a very serious outbreak of the cankerworm in his orchard in Canada and that he had used bands, saturated with a castor oil and resin mixture, around the trees. Several thousand trees had been banded and on these trees, so far as he knew, there had been no cankerworms the present spring. It had required some time to inspect them and some experimentation was necessary before the effective proportion of the ingredients had been determined. It was extremely satisfactory as far as his experience had gone.

Mr. Quaintance inquired what proportion of oil and resin had been used, to which Mr. Fisher replied that 3 pounds of castor oil was used to 5 pounds of resin. The materials were warmed to thoroughly break up the resin, but were applied cold.

Mr. Osborn stated, in reference to the treatment of the cankerworm, that it was the practice to spray the trees with arsenate of lead or Paris green as soon as possible after the larvæ had made their appearance. He stated that at this time the insects were much more susceptible to treatment than later when the larvæ were more nearly full grown.

Mr. Smith stated that Dr. Howard had desired the observation of members in reference to the elm leaf beetle, and in regard to this insect he stated that it was more abundant in New Jersey the present year than for some time past. Four years ago there had been a great scarcity of the insect and two years before this it had not been necessary to do any spraying at all. Last year the insects began to increase to some extent and it was necessary to spray to destroy the larvæ. This year they were in large numbers and it had become necessary to spray while the beetles were feeding. By this means the beetles were largely killed off, but quite a number of larvæ had come through from the egg. In speaking further of shade-tree insects, Mr. Smith stated that the fall webworm promises to be more abundant in New Jersey this year than last. There had been a very great increase of this species the latter part of that year, and trees were considerably injured. The insects were not especially abundant in the early part of the season, but this year they had been destructive already. They had appeared so abundantly at the experiment station that he found it necessary to spray with arsenate of lead, and he thought, from the present condition, there would likely be a great increase of this species throughout the State before the season was out.

Mr. Felt spoke of the increase of this beetle and of the work of the green fruit worm.

Mr. Smith replied that he had not observed the green fruit worm

to occur in New Jersey as a pest, but very early in the spring specimens had been sent him from a greenhouse man in Morris County. There were quite a number of specimens sent, and he had been informed that at various places there was a considerable amount of injury that had been done and was being done by this insect. Mr. Smith said he was much interested in the remarks of Mr. Sanderson concerning the chimney making of the periodical Cicada. He had never seen more perfect specimens than those exhibited by Mr. Sanderson, from Delaware.

Mr. Sanderson explained that these chimneys occurred only under buildings.

Mr. Scott at this point called attention to the coming meeting of the Association of Agricultural Colleges and Experiment Stations to be held in Atlanta, Ga., during October. He extended an invitation to the section of entomology and to the horticultural inspectors who might be present to take part in an excursion over the State, for which it was his desire to arrange.

Mr. Quaintance referred briefly to some of the entomological features in Maryland for the year. Attention was called to the strawberry beetle, which had been very abundant in the strawberry fields in Maryland and had cut off a considerable quantity of the bloom. The growers had estimated that from 35 to 50 per cent of the flowers had thus been cut off. At Greensboro and Ridgely they had adopted planting certain varieties which were very profuse bloomers, and the results were that the effect of the insect was rather beneficial than otherwise, as it tended to thin out the fruit, giving a better size and quality. Another insect that had proven to be somewhat injurious locally was the New York plum weevil. It had been reported by one orchardist as attacking the opening buds in the spring and doing considerable injury. Beetles were confined in breeding cages, and eggs and larvæ of the insect had been secured in considerable quantity. The eggs were deposited on leaves and protected by a fold. They were laid in masses of from 6 to 30. The larvæ inhabit the soil, immediately penetrating beneath as they hatch from the egg. They had been observed to feed on the roots of grass. Another insect that had been locally abundant was a species of grasshopper, *Melanoplus bivittatus*. An outbreak of this species occurred in Washington County, and it had been very injurious to clover. In one large field the clover crop had been largely destroyed. Adjacent to this field was a newly planted apple orchard, and the trees were doing nicely. The cutting of the clover forced the grasshoppers to the apple orchard, and the insects had attacked the trees, chewing the bark. In many cases the trees were entirely stripped of bark. The pea louse, which had been quite injurious in former years, was not now considered of great importance from the fact that growers planted only early varie-

ties. The pea louse was not observed to be present in pea fields until after the middle of June. The fall webworm was quite abundant in Maryland this year, and was generally distributed all over the State.

Mr. Burgess stated that the plum curculio had done considerable injury to apples in northern Ohio the present year. The plum crop had also been severely injured.

Mr. Smith stated that there had been considerable injury in the southern part of New Jersey from the strawberry weevil, but it had not made its appearance in the northern part. While the injury had been rather extensive, he questioned if the loss had been of much real importance, owing to the beneficial effect of the thinning of the fruit. In reference to the pea louse, Mr. Smith stated that in the past some of the pea fields suffered quite a good deal, but up to this time in the present season the insects had not appeared in any number. A species of louse has been abundant on clover, but he did not learn of this until after the clover had been cut. He did not know whether or not there was any relation between the insect on clover and the pea louse.

Mr. Sanderson stated that the only information in reference to the occurrence of the pea louse in Delaware that had come to him was from reports, but it was his opinion that the insect had been of but little importance.

Mr. Hopkins inquired of Mr. Quaintance if the early planting of peas had been the result of entomological investigation.

Mr. Quaintance stated that he was not able to say, and referred the question to Mr. Sanderson, who replied that he did not know who had first suggested the plan of planting early varieties of peas to get around the injury from the pea louse. He thought that possibly it had been done by Professor Johnson. Mr. Sanderson stated that early peas both this year and last had been practically free from the insect. The remedy had been brushing, following by a cultivator, and in New Jersey a sprayer had been used.

Mr. Webster stated that the planting of early varieties of peas was the practice followed in Ohio.

Mr. Smith remarked that he had given the advice to plant early as soon as the life history of the insect had been worked out and in his first publication on the subject. In New Jersey he found it was safe to count on practical freedom from the insect until the middle of June.

Mr. Bogue, in speaking of the melon louse, thought that this insect could be readily killed by fumigation. He was much interested in the matter of parasites of this species. In regard to the grapevine-root worm, he thought that possibly the farmers had a remedy in the use of chickens which would help them some. Fowls had been used with good success with other insects. If the beetles were knocked off, he thought the fowls would destroy a great many of them.

Mr. Smith stated in reference to the melon aphid that fumigating with carbon bisulphid was common in New Jersey, and that a number

of growers had a considerable supply of caps or covers for fumigating their vines. A close lookout is kept for the insect early in the season, and they endeavor to destroy the first infestation. Covers to the number of 10, 20, or even 50 were kept going for two or three days, and in this way all early infestation was destroyed.

Mr. Marlatt, referring to the reports on the periodical cicada, stated that the cicada turrets were very rare in Washington this year, and had only been found in a single instance. In this case they occurred in the woodshed of a gentleman living on Washington Heights, on the outskirts of the city. This woodshed had an earthen floor which was slightly moist, but not more so than the ground outside. The cicadas had come up in this shed in great numbers, and in every instance had built a turret varying in height from 1 to 6 inches. Without the shed the cicadas had come up in equal numbers, but through simple holes in the ground, without any sign of a turret. The explanation of the presence of the cicada turrets within this shed would be somewhat difficult. He had suggested that perhaps it was due to the darkness in the shed which led the cicadas to build their galleries above the surface of the soil in the effort to reach broad daylight.

Referring to the elm-leaf beetle, he said that Doctor Howard had already called attention to its practically complete absence in the elm grove on the grounds of the Department of Agriculture this year. This elm grove, he said, had been filled with beetles every year since he had been connected with the Department, and before it became the habit to have it properly sprayed the trees had been regularly defoliated. The complete absence of the insects this year was, therefore, rather remarkable. They were also very rare throughout the city, not doing more than one-tenth the damage of other years.

Mr. Hopkins stated that Doctor Felt's paper on pine insects had interested him, and it was his opinion that the collected beetles had not been the cause of the eradication of the insect the following year. This species is attacked by a parasite, *Bratcon strobil*, which reduces it, and he thought probably this should be considered an important factor in their scarcity the following year. In regard to the pine Tomieus, Mr. Hopkins stated as a rule it would not attack perfectly healthy trees. In Germany there were two or three species regarded as injurious to pine forests. They prefer to attack injured trees, especially felled ones. He spoke of the new field of investigation to which he had been assigned with the Department of Agriculture—namely, the study of forest insects—and solicited the cooperation of entomologists of the different States and expressed his own desire to cooperate with the entomologists whenever possible. He considered that there was much room for original observation and thought much good would likely result from cooperative work.

Mr. Webster observed that the use of the term "States" he con-

sidered to be wrong. He thought too much distinction was drawn on State lines. Insects occur all over the country, and he thought life zones or geological boundaries were more proper terms to use. Mr. Webster further stated that refined kerosene had been used extensively in southern Ohio without injury to apple trees, but applied in less quantities in other parts of the State trees had been killed. He spoke of the need of investigation of the effect of mineral oil upon plants. He thought there were factors that were not understood.

Mr. Smith remarked that he agreed with Professor Webster in reference to the word "State," but it served in another way to express the actual facts that different workers had obtained varying results, and was really a designation of a worker in any given State.

Mr. Sanderson called attention to the fact that a record of the weather as made by the Weather Bureau was conducted somewhat along this line. He stated that he had had occasion to look up the weather record, and was able to secure the data from the State bureau.

Mr. Smith stated that in New Jersey there was a tabulated record for every locality at which a station is established, and that he was thus able to secure the weather record for ten or more years back without much trouble.

Mr. Hopkins observed that in West Virginia he had concluded it was not safe to base conclusions on the work of voluntary weather observers. Stations were at different elevations along the line, east and west. He considered the influence of climate as shown by the difference in flowering periods of plants to be of considerable use in this connection.

The president called attention to the matter of a small assessment of the members present to meet the current expenses of the secretary, and on motion it was voted to assess each member 50 cents.

It was voted to hold the next meeting at the same place of meeting of the American Association for the Advancement of Science, namely, Washington, D. C. After some discussion as to the exact date of meeting, it was voted to leave this to the officers of the association, the date to be announced by the secretary in the preliminary notice.

The meeting then adjourned.

CALLED MEETING, SATURDAY, JUNE 28, 1902.

A called meeting of the association was held in the Schenley Hotel, June 28, at 5 p. m., to consider the matter of electing representatives to the council of the American Association for the Advancement of Science, the association being entitled to this representation. Mr. Hopkins moved that two fellows be elected to the council, and a ballot was taken, with the result that Mr. A. D. Hopkins and Mr. C. L. Marlatt were elected.

A. L. QUAINANCE, *Secretary.*

LIST OF MEMBERS OF THE ASSOCIATION OF ECONOMIC ENTOMOLOGISTS.

ACTIVE MEMBERS.

Aldrich, J. M., Agricultural Experiment Station, Moscow, Idaho.
Alwood, William B., Agricultural Experiment Station, Blacksburg, Va.
Ashmead, William H., U. S. National Museum, Washington, D. C.
Baker, C. F., Stanford University, California.
Ball, E. D., Agricultural Experiment Station, Fort Collins, Colo.
Banks, C. S., Bacolod, Negras, Philippine Islands.
Banks, Nathan, U. S. Department of Agriculture, Washington, D. C.
Barrows, W. B., Agricultural College, Michigan.
Benton, Frank, U. S. Department of Agriculture, Washington, D. C.
Bethune, C. J. S., 500 Dufferin avenue, London, Ontario, Canada.
Bogue, E. E., Columbus, Ohio.
Britton, W. E., New Haven, Conn.
Bruner, Lawrence, Agricultural Experiment Station, Lincoln, Nebr.
Burgess, Albert F., State Department of Agriculture, Columbus, Ohio.
Busek, August, U. S. Department of Agriculture, Washington, D. C.
Caudell, A. N., U. S. Department of Agriculture, Washington, D. C.
Chambliss, C. E., Clemson College, S. C.
Chittenden, F. H., U. S. Department of Agriculture, Washington, D. C.
Clifton, Richard S., U. S. Department of Agriculture, Washington, D. C.
Cockerell, T. D. A., East Las Vegas, N. Mex.
Comstock, J. H., Cornell University, Ithaca, N. Y.
Cook, A. J., Pomona College, Claremont, Cal.
Cooley, R. A., Agricultural Experiment Station, Bozeman, Mont.
Coquille, D. W., U. S. Department of Agriculture, Washington, D. C.
Cordley, A. B., Agricultural Experiment Station, Corvallis, Oreg.
Ehrhorn, E. M., Mountainview, Cal.
Felt, Ephraim P., Geologic Hall, Albany, N. Y.
Fernald, C. H., Agricultural College, Amherst, Mass.
Fernald, H. T., Agricultural College, Amherst, Mass.
Fiske, W. F., State Capitol, Atlanta, Ga.
Fletcher, James, Central Experimental Farm, Ottawa, Canada.
Forbes, S. A., University of Illinois, Urbana, Ill.
Fowler, Carroll, Agricultural Experiment Station, Berkeley, Cal.
Garman, H., Agricultural Experiment Station, Lexington, Ky.
Gibson, Arthur, Central Experimental Farm, Ottawa, Canada.
Gillette, C. P., Agricultural Experiment Station, Fort Collins, Colo.
Gossard, H. A., Agricultural Experiment Station, Lake City, Fla.
Gregson, P. B., Waghorn, Alberta, North West Territory.
Hart, C. A., University of Illinois, Urbana, Ill.
Hargitt, C. W., Syracuse University, Syracuse, N. Y.

Hillman, F. H., U. S. Department of Agriculture, Washington, D. C.
 Hine, J. S., Ohio State University, Columbus, Ohio.
 Holland, Dr. W. J., Pittsburg, Pa.
 Hopkins, A. D., U. S. Department of Agriculture, Washington, D. C.
 Howard, L. O., U. S. Department of Agriculture, Washington, D. C.
 Hunter, W. D., U. S. Department of Agriculture, Washington, D. C.
 Hunter, S. J., University of Kansas, Lawrence, Kans.
 Kellogg, Vernon L., Stanford University, California.
 Kincaid, Trevor, University of Washington, Seattle, Wash.
 Kirkland, A. H., Malden, Mass.
 Lochhead, Wm., Guelph, Ontario.
 Lowe, V. H., Agricultural Experiment Station, Geneva, N. Y.
 Marlatt, C. L., U. S. Department of Agriculture, Washington, D. C.
 McCarthy, Gerald, care of Crop Pest Commission, Raleigh, N. C.
 Morgan, H. A., Agricultural Experiment Station, Baton Rouge, La.
 Newell, Wilmon, College Station, Tex.
 Osborn, Herbert, Ohio State University, Columbus, Ohio.
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 Pettit, R. H., Agricultural Experiment Station, Agricultural College, Michigan.
 Phillips, J. L., Agricultural Experiment Station, Blacksburg, Va.
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 Quaintance, A. L., Agricultural Experiment Station, College Park, Md.
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 Walker, C. M., Agricultural Experiment Station, Albany, N. Y.
 Washburn, F. L., St. Anthony's Park, Minnesota.
 Webster, F. M., University of Illinois, Urbana. Ill.
 Weed, C. M., Agricultural Experiment Station, Durham, N. H.
 Wilcox, E. V., U. S. Department of Agriculture, Washington, D. C.
 Woodworth, C. W., Agricultural Experiment Station, Berkeley, Cal.

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Adam, M. F., City Bank building, Buffalo, N. Y.
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 Frost, H. L., 21 South Market street, Boston, Mass.
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Gould, H. P., U. S. Department of Agriculture, Washington, D. C.
 Harrington, W. H., Post-Office Department, Ottawa, Canada.
 Hudson, G. H., Normal and Training School, Plattsburg, N. Y.
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 Mann, B. P., 1918 Sunderland place, Washington, D. C.
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 Townsend, C. H. T., El Paso, Tex.

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 Carpenter, Prof. George H., Science and Art Museum, Dublin, Ireland.
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 Fuller, Claude, Department of Agriculture, Pietermaritzburg, Natal, South Africa.
 Giard, A., 14 Rue Stanislaus, Paris, France.
 Goding, F. W., Newcastle, New South Wales.
 Grasby, W. C., Grenfell street, Adelaide, South Australia.
 Green, E. E., Royal Botanic Gardens, Punduloya, Ceylon.
 Helms, Richard, 136 George street, North Sydney, New South Wales.
 Horvath, Dr. G., Musée Nationale Hongroise, Budapest, Austria-Hungary.
 Lampa, Prof. Sven, Statens Entomologiska Anstalt, Albano, Stockholm, Sweden.
 Lea, A. M., Department of Agriculture, Hobart, Tasmania.
 Leonardi, Gustavo, Portici, Italy.
 Lounsbury, Charles P., Department of Agriculture, Cape Town, South Africa.
 Mally, C. W., Department of Agriculture, Cape Town, South Africa.
 Marchal, Dr. Paul, 16 Rue Claude Bernard, Paris, France.
 Musson, Charles T., Hawkesbury Agricultural College, Richmond, New South Wales.
 Newstead, Robert, Grosvenor Museum, Chester, England.
 Peal, H. W., Indian Museum, Calcutta, India.
 Porchinski, Prof. A., Ministère de l'Agriculture, St. Petersburg, Russia.
 Reed, E. C., Rancagua, Chile.
 Renter, Dr. Enzo, Fredriksgatan 45, Helsingfors, Finland, Russia.
 Sajo, Prof. Charles, Gödöllő-Veresegyház, Austria-Hungary.

- Schöyen, Prof. W. M., Zoological Museum, Christiania, Norway.
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Tryon, H., Queensland Museum, Brisbane, Queensland, Australia.
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Vermorel, V., Villefranche, Rhône, France.
Whitehead, Charles, Barming House, Maidstone, Kent, England.

CONSTITUTION, ASSOCIATION ECONOMIC ENTOMOLOGISTS.

This association shall be known as the Association of Official Economic Entomologists.

Its objects shall be: (1) To discuss new discoveries, to exchange experiences, and to carefully consider the best methods of work; (2) to give opportunity to individual workers of announcing proposed investigations, so as to bring out suggestions and prevent unnecessary duplication of work; (3) to suggest, when possible, certain lines of investigation upon subjects of general interest; (4) to promote the study and advance the science of entomology.

The membership shall be confined to workers in economic entomology. All economic entomologists employed by the General or State governments or by the State experimental stations, or by any agricultural or horticultural association, and all teachers of economic entomology in educational institutions may become members of the association by transmitting proper credentials to the secretary and by authorizing him to sign their names to this constitution. Other persons engaged in practical work in economic entomology may be elected by a two-thirds vote of the members present at a regular meeting, and shall be termed associate members. Members residing outside of the United States or Canada shall be designated foreign members. Associate and foreign members shall not be entitled to hold office or to vote.

The officers shall consist of a president, two vice-presidents, and a secretary, to be elected annually, who shall perform the duties customarily incumbent upon their respective offices. The president shall not hold office for two consecutive terms.

The annual meeting shall be held at such place and time as may be decided upon by the association at the previous annual meeting. Special meetings may be called by a majority of the officers, or shall be called on the written request of not less than five members. Eight members shall constitute a quorum for the transaction of business.

The mode of publication of the proceedings of the association shall be decided upon by open vote at each annual meeting.

All proposed alterations or amendments to this constitution shall be referred to a select committee of three at any regular meeting, and, after a report from such committee, may be adopted by a two-thirds vote of the members present: *Provided*, That a written notice of the proposed amendment has been sent to every voting member of the association at least one month prior to date of action.

BY-LAWS.

ARTICLE I.—*Of members.*

SECTION 1. The classes of members are defined in the constitution, as are their rights to vote or hold office. Members of all kinds have equal privileges as to presentation of papers and in the scientific discussions at the regular meetings, and may, by permission of the presiding officer, speak on business questions before the association.

SEC. 2. All members have equal rights to the published proceedings of the association and to any publications controlled by or distributed by the association, save that should any publications of economic interest be distributed by the association the distribution lists furnished by the active members are first to be regarded.

ARTICLE II.—*Of officers and their duties.*

SECTION 1. It shall be the duty of the president, in addition to the ordinary duties of a presiding officer, to prepare and deliver an annual address, to be delivered at the annual meeting over which he presides.

SEC. 2. It shall be the duty of the secretary to provide the necessary stationery and such books as he may be directed to provide, the expenses for which shall be met by an assessment of not less than 25 cents on the members in attendance at the meetings. The sum so collected shall be used by the secretary to reimburse himself for advances made and to meet the ordinary expenses of the association. An account shall be rendered at each annual meeting, and, if needed, an additional assessment shall be imposed.

SEC. 3. All officers shall be elected by ballot after open nomination, and this by-law shall not be suspended except by unanimous consent of the voting members present.

ARTICLE III.—*Of meetings.*

SECTION 1. Notice of the time and place of meetings shall be published in all the American entomological periodicals and in *Insect Life*.

SEC. 2. Special meetings shall be called as provided for in the constitution, and notice of such meetings shall be given by the secretary by mailing to each voting member a formal specification of the time and place of meeting at least two weeks before the date fixed in the notice. The notice shall state the reason for such meeting, and shall specify the business to be transacted, and no other business shall be transacted.

SEC. 3. The order of business at regular meetings shall be, at the first session:

- (1) Calling the meeting to order by the president.
- (2) The annual address by the president.
- (3) Reports of officers.
- (4) Reports of committees.
- (5) Proposal and election of members.
- (6) Written business communications.
- (7) Verbal business communications.
- (8) New business.
- (9) Programme of papers and discussions.
- (10) Adjournment.

At the following sessions:

- (1) Reading and action on the minutes of previous meetings.
- (2) Unfinished business.
- (3) Proposal and election of members.
- (4) New business.
- (5) Programme of papers and discussions.
- (6) Adjournment.

At the last session of the meeting the order of business shall be as at other sessions, except that after order (5) will come:

- (6) Election of officers for the next meeting.
- (7) Fixing time and place of next meeting.
- (8) Reading and action on rough minutes of the entire session.
- (9) Final adjournment.

ARTICLE IV.—*Amendments to by-laws.*

SECTION 1. Changes in these by-laws may be made at any regular meeting in the same manner and on the same notice as prescribed in the constitution for amendments to that instrument.

U. S. DEPARTMENT OF AGRICULTURE,

DIVISION OF ENTOMOLOGY—BULLETIN NO. 88, NEW SERIES.

L. O. HOWARD, Entomologist.

S O M E

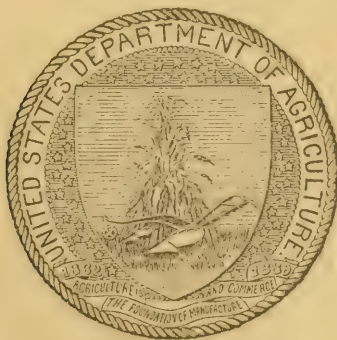
MISCELLANEOUS RESULTS

OF THE

WORK OF THE DIVISION OF ENTOMOLOGY.

V I.

PREPARED UNDER THE DIRECTION OF THE ENTOMOLOGIST.



234755

WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1902.

DIVISION OF ENTOMOLOGY.

L. O. HOWARD, *Entomologist.*

C. L. MARLATT, *Entomologist in charge of experimental field work.*

F. H. CHITTENDEN, *Entomologist in charge of breeding experiments.*

A. D. HOPKINS, *Entomologist in charge of forest insect investigations.*

FRANK BENTON, *in charge of apiculture.*

W. D. HUNTER, *in charge of cotton-boll weevil investigations.*

D. W. COQUILLET, TH. PERGANDE, NATHAN BANKS, *Assistant Entomologists.*

E. A. SCHWARZ, C. B. SIMPSON, *Investigators.*

MISS H. A. KELLY, *expert in sericulture.*

R. S. CLIFTON, F. C. PRATT, AUGUST BUSCK, OTTO HEIDEMANN, A. N. CAUDELL,
J. KOTINSKY, *Assistants.*

W. E. HINDS, G. H. HARRIS, H. E. BURKE, *Temporary field agents.*

MISS L. SULLIVAN, *Artist.*

U. S. DEPARTMENT OF AGRICULTURE,

DIVISION OF ENTOMOLOGY—BULLETIN NO. 38, NEW SERIES.

L. O. HOWARD, Entomologist.

S O M E

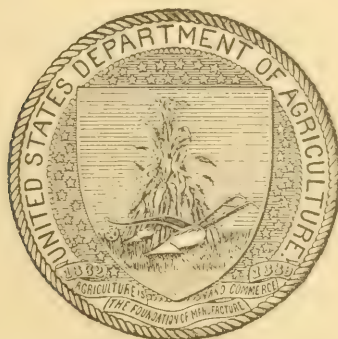
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,

DIVISION OF ENTOMOLOGY,

Washington, October 6, 1902.

SIR: I have the honor to transmit the manuscript of several articles and shorter notes, none of which are of such a nature as to justify their publication in separate form. The matter presented is similar to that which has been published in other bulletins of this series, namely, in Bulletins 7, 10, 18, 22, and 30; and I recommend the publication of the present material under the title "Miscellaneous Results of the Division of Entomology, VI," as Bulletin No. 38, new series, of this Division.

Respectfully,

L. O. HOWARD,

Entomologist.

Hon. JAMES WILSON,

Secretary of Agriculture.

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SOME MISCELLANEOUS RESULTS OF THE WORK OF THE DIVISION OF ENTOMOLOGY.

VI.

THE SOUTHERN GRAIN LOUSE.

(*Toxoptera graminum* Rondani.)

By THEO. PERGANDE.

INTRODUCTION.

Aphis graminum Rond., Nuovi Ann. della Science, Series III, Vol. VI, p. 10, 1852.

Toxoptera graminum Passerini, Aphididæ Italicæ, p. 28, 1863.

This destructive little aphidid was first observed and described under the name of *Aphis graminum* by Dr. C. Rondani, who stated that the winged migrants were swarming during the month of June in immense numbers in the streets of Bologna to the great annoyance of the inhabitants. In connection with his description he gives a list of the following graminaceous plants on which this plant-louse had been observed to feed: Oats (*Avena sativa* and *clatior*); wheat (*Triticum vulgare*); spelt (*Triticum spelta*); couch grass (*Triticum repens*); *Hordeum marinum*; soft chess (*Bromus mollis*), and corn (*Zea mais*).

A lengthy article on the grain aphid was also published the same year by Dr. Dom. Luigi Mazzanti (Nuov. Ann. Sc. Nat. Bologna, Ser. III, Vol. 6, pp. 342-352), which I have been unable to consult.

Dr. J. Passerini redescribed this species in 1863 (Aphididæ Italicæ, Genoa, pp. 28, 29), removing it to Koch's genus *Toxoptera*. He mentions as its food plants *Triticum*, *Hordeum*, *Avena*, *Zea*, and *Sorghum*. The same food plants were also mentioned by Passerini (Flora degli Afidi Italiani; Bul. Soc. Ent. Ital., Vol. III, pp. 151, 248, 340, and 343).

In 1884 Dr. G. Horvath, of Budapest, Hungary, published some observations on this species ("Rovartoni Lapok," vol. 1, pp. 143-145 and XIX, and a second article on the same insect in "Fauna Regni Hungariæ," p. 60, 1897), dividing the area infested by it into regions, Regions I-IV comprising the central, eastern, and northern sections, and VI the southernmost central area. Neither of these publications is at my command.

An interesting article on the destructiveness of this species to oats was published by Dr. Karl Sajo, Budapest, Hungary (Zeitschrift für

Pflanzenkrankheiten, Beiträge zur landwirthschaftlichen Insektenkunde, Vol. IV, p. 4, 1894). He says:

Fifteen or sixteen years ago I always raised excellent oats on a field bordering a meadow; all of the plants were of a strong and healthy growth, and about one meter in height. Later, however, notwithstanding heavy manuring, the stalks became gradually more slender and lower, and the crop of the grain so scant as not to pay for cultivation. Happening once to inspect the grain during summer at the proper time, I found that the cause of the decline was a plant-louse, which Dr. Geza v. Horvath, at Kecskemét, in 1884, discovered to be the cause of "reddening" of the leaves and the total destruction of the young plants, and which proved to be the grain aphid, *Toxoptera graninis* Rond.

It occurred to me that, by abandoning the common or Bauern oats and replacing it by finer and stronger varieties, they might be able to successfully withstand the attacks of the Toxoptera. I was, however, much mistaken. I planted on some of my best fields adjoining the meadow a row of triumph oats, Anderbeck oats, and the common Bauern oats, and found that lice showed a decided preference for the finer varieties with broad, bandlike, and juicy leaves, particularly the triumph oats. Of this variety absolutely nothing was left; all of the plants were destroyed before they reached a few inches in height; the whole field was completely ruined as if it had been swept by fire. Anderbeck oats resisted somewhat, though not much better, whereas the common oats showed the best results, of which at least half a crop was obtained.

I am of the opinion that this invasion of the aphides had its origin in the meadow, because the trouble began first along the edge of the meadow and spread gradually to the middle of the field. Unfortunately all of my fields suitable for the cultivation of oats are in the immediate neighborhood of meadows or along patches of grass, while the more distant fields are of a sandy nature and can only be used for cultivation of rye, corn, etc., which renders a comparison impossible.

The consequences, therefore, were that I had to reduce the cultivation of oats to a minimum and to replace it with fodder corn, turnips, clover, etc.

Professor Sajo (p. 150, loc. cit.) says that this species has probably nowhere else, except in Hungary, shown itself to be so destructive, but that in Hungary it is one of the most destructive enemies of barley and oats. He states that its destructive habits were first described by Dr. G. v. Horvath, who discovered it to be the cause of the reddening of the oats at Kecskemét, and that during the following years similar complaints were reported from the provinces of Baes-Bodrog, Borsod, and Csanad.

The latest contributions regarding the food plants of this species were published by Dr. Giac. Del Guercio (Nuove Relazioni R. Staz. di Entom. Agraria, Firenze, serie prima, No. 2; Prospetto Dell'Afidofauna Italia, p. 145, 1900) with the statement that this plant louse is found in considerable numbers on *Triticum vulgare*, *Hordeum vulgare*, *Avena sativa*, *Zea mais*, *Dactylis glomerata*, *Bromus* sp., and *Lolium perenna*.

HISTORY OF THE SPECIES IN AMERICA.

The earliest record in the possession of the U. S. Department of Agriculture of the presence of this pest in the United States dates

back to June, 1882. Unfortunately, however, the locality from which the insects were received was not obtained.

In June of 1884 this species was discovered on wheat at Cabin John Bridge, Md., though not in sufficient numbers to cause any appreciable damage. During summer and fall of the same year, and January of 1885, specimens were observed by Prof. F. M. Webster at Oxford, Ind., on wheat transferred from the field to breeding cages, in which they continued to breed and multiply, enabling him to make some interesting observations on the rapidity of reproduction of the species. On isolating some pupæ, which soon became winged, he found that during the following twenty days they produced about 40 young, or at a rate of 1 to 4 a day; as a rule, however, the apterous or wingless females are still more prolific.

During June of 1890, after an intermission of about five or six years, this grain louse again became quite abundant, and was found in Indiana by Professor Webster in injurious numbers upon wheat at Lafayette and in southern portions of the State, while in Posey County, in the extreme southwestern section, they were so numerous, both on the fully developed and on the tender unfolding leaves of wheat, as to cover them in some cases completely. The oat crop was a total failure; many of the fields were as brown as though the plants had been winterkilled. During the same year they spread over a large area of some of the grain-producing States of the South. They were first reported about the middle of January by Mr. P. C. Newkirk, Jalapa, Monroe County, Tenn., as being very injurious, killing all the wheat in his section. The following March he wrote again that the insects had not been able to survive the heavy rains and frost of the month, as far as he could see, though much damage had been done to wheat, patches the size of an acre or more being apparently dead, and he had doubts that one of his fields would recover from the damage done.

January 29, 1890, it was reported by Mr. B. F. White, Mebane, Alamance County, N. C., as ruining all the wheat and oats there. February 26 specimens of this insect were sent to this office by Mr. J. L. Fookes, Era, Cook County, Tex., with the statement that the species had played sad havoc with the wheat in that section. In a communication of the 31st of March Mr. Fookes writes:

You ask me about the amount of damage done to the crop and how long they have abounded in our fields. It is believed now that they have been in the fields since early fall; they still remain in great numbers in some fields. As to the amount of damage, we place it, after a careful estimate, at 75 per cent in one-half of this county, which includes the wheat belt. One-half will be planted in other crops and the remainder will be about one-half stand. There are some small crops of Fultz wheat which are not hurt. The rest of the crop is Mediterranean wheat.

Early in April specimens were received from Mr. D. J. Eddleman, Denton, Denton County, Tex., with the statement that the species was

destroying the wheat. It was also received June 2 from Mr. J. G. Barlow, Cadet, Mo., who observed it to be very injurious to oats.

REPORTED INJURY DURING 1901.

During the spring of 1901 this species became extremely numerous in the grain belt of Texas, as the communications received during that year show.

Mr. W. R. Peters, Caddo Mills, Tex., wrote March 15: "I inclose you a sample of red winter wheat that has been killed by a small green bug. The wheat in our county is badly damaged by the insect. I have 50 acres destroyed by this bug." The same day specimens were also received from Mr. C. A. Kelsey, Sherman, Tex., who said: "These little flies are fast destroying the young wheat; they are beginning to sap the oats, and have been working on the grain since early fall."

Mr. H. K. Jones, Valley View, Tex., in a letter dated March 16, says:

I inclose you a sample of insects which are killing the young wheat in this section; they are on the wheat by the million. They first made their appearance about ten years ago, at which time they killed all the wheat, or about all, in this county, and what was left made only 1 to 3 bushels per acre. The next time we noticed them was last year, when they made their appearance early in spring. After the wheat headed they went to the heads, and we thought they would surely ruin the wheat, but we had a good yield; after the wheat headed we had a great deal of rain, which may account for it. We first noticed them this season in December last; they were not numerous, but have been increasing ever since. We find that cold does not hurt them; they have gone through a zero spell and come out all right; have seen the wheat covered with sleet and the bugs frozen up, but on thawing they seemed to be as hungry as ever. Wet weather is no drawback to them; we have just had a good rain a week ago, but the wheat looks worse and the bugs better.

Mr. J. C. Coit, Denton, Tex., wrote March 18 that wheat in his section was badly injured by this insect and that a few days previous it was noticed that the wheat did not have so deep a color as usual at that season. Upon an investigation it was found that the outer leaves of the wheat were dead. The aphides were found on the ground under the protection of the leaves, in some spots as many as six or eight around the same plant. In 1890 the wheat was destroyed by this or some similar pest.

In a communication from Mr. B. H. Hamilton, Weston, Tex., March 18, it was stated that this insect was ruining the wheat in that part of Texas, that it had been at work for six or eight days prior to the date of writing, and it was noticed that on striking a bunch of wheat the ground would be covered with numbers of the insects. It was in that vicinity this year (1902), but did not appear until the last of April or first of May.

March 26 Mr. F. C. Ratcliff, Vernon, Willbarger County, Tex., reported that this louse infested the wheat fields, and that the crop in some parts of that county was suffering from its depredations.

March 27 Mr. Oswald Wilson observed this species on wheat near Houston, Tex., and on the 10th of April near McKinney, Tex.

March 29 Mr. D. M. Hamilton, Austin, Tex., reported that these plant-lice were worse on stubble land of wheat than on corn or cotton land.

On the 1st of April specimens were received from Mr. J. Booze, Sherman, Tex., who stated that "these flies or gnats" are very numerous in low places and that they had entirely destroyed the oats and wheat.

Under date of April 22 Mr. A. E. Jenks, of the American Thresherman, Madison, Wis., forwarded to this office specimens of this insect received from Elmont, Grayson County, Tex., with the report that wheat, oats, and corn were all ruined by it, and that during the year or two previous it had done great injury to these crops in Texas. On the same date the following note was received from Mr. S. E. Russell, Fate, Tex.: "I send you herewith a few of the little green bugs which are destroying our crops in toto. Wheat and oats are gone; there are not so many on corn to-day."

Specimens were also received April 24 from Ralli Brothers, New York City, which they had obtained from their Greenville, north Texas, cotton agency, with the accompanying report:

This insect has seriously injured wheat and oats and is now attacking young corn. Wherever they have attacked wheat or oats the field looks as though it had been swept by fire. A number of farmers have been forced to plow up their wheat and plant corn.

A letter was received April 25 from Mr. J. W. Bussell through the American Thresherman, complaining of injuries by this insect at Mountain Peak, Tex., saying that it was playing havoc with the grain crop there; oats were entirely ruined, and wheat cut 50 per cent.

April 30 specimens were received from Mr. J. C. Crispin, Saratoga, McDonald County, Mo., with report that this insect was very numerous on wheat, and that some fields might have to be plowed up.

In a communication of May 14, Mr. W. E. Campbell, of Ralli Brothers Agency, Greenville, Tex., stated that a few days previous to writing the weather became quite warm, causing the insects to leave that section and go farther north. They appeared to be better suited to cold, damp weather. A number of fields in that vicinity were visited where the insects had been particularly troublesome, without finding a specimen at that time, the warmer weather having apparently driven them completely out of the country.

NEWSPAPER REFERENCES TO INJURIOUS OCCURRENCES IN 1901.

Numerous clippings were received from newspapers relative to the spread of this grain louse and destruction wrought by it to small grain crops in Texas and adjoining territory during the spring of 1901. The following are transcribed:

[Galveston News, March 21.]

Denton, Tex., March 18.—W. E. Smoot, of Argyle, was here to-day with a quantity of the little green insects that are doing so much damage to the wheat. The insects are present in myriads and the big wheat farmers are taking a very gloomy view of the prospect, many of them believing that their crops are irreparably ruined. Many of them, in fact, are making preparations to plant the injured wheat land in cotton or corn.

Farmers who were here ten years ago say that the present visitation is exactly like that of 1891 and that the entire wheat crop of several counties was almost entirely lost, some of the yield being as low as half a bushel to the acre and the highest not more than 10 bushels.

Gainesville, Tex., March 12.—Dr. W. H. Freeman, who lives at Era, 15 miles west of Gainesville, in speaking of the growing wheat, said: "The wheat in my section is literally ruined, and the farmers will have to plow it up and plant the ground in corn and other products."

Sherman, Tex., March 18.—The condition of the wheat crop from the inroads of the Hessian fly or some similar pest is attracting much attention. In some localities it is said that the wheat crop will be plowed up and cotton or some other late crop planted instead.

[Dallas (Tex.) Herald, March 21.]

Sherman, Tex., March 21.—Great alarm is felt here by the farmers at the ravages of a small green bug that is infesting the wheat and oats.

[Dallas (Tex.) Herald, March 22.]

W. H. Marshall, a prominent farmer of Whitesboro, Grayson County, said: "The reports about the damage being done to the wheat in our part of the State are not exaggerated in the least. Hundreds of acres have been killed around Whitesboro and in other parts of Grayson County. The flies have also gotten into Collin County and are doing considerable damage there, and some damage has been done in Denton County. Unless the ravages are checked soon we will have to buy our flour and seed wheat."

[St. Louis (Mo.) Republic, March 24.]

Reports from Texas say that at least 25 per cent of the wheat crop in the northern part of the State has been ruined by the bug, and the entire crop is threatened.

The insects are seen in countless numbers in the growing wheat. Advices from all parts of Texas say that the pest is spreading, but appears to be working only the stubble-ground wheat.

Owing to the mildness of the winter, instead of being killed it propagated rapidly, and apprehensions are felt for the entire crop. So far wheat on the cotton ground does not appear to be damaged.

[Galveston (Tex.) News, March 26.]

Waxahachie, Tex., March 26.—Mr. B. F. Cherry, of Midlothian, this county, reported that a little green bug was doing a great deal of damage to wheat in that

section of the county and that some of the wheat fields near there had been almost entirely destroyed by the insect.

Hutchins, Tex., March 26.—Mr. A. W. Carnes writes to the News that he has just returned from an examination of the wheat and oat fields upon the county farm, and finds that the entire oat crop—30 acres—and 15 acres in a wheat crop of 75 acres, have been entirely destroyed. The bugs are still working upon the wheat, marching from east to west, maintaining a straight line from north to south, as though they were under the leadership of a trained tactician.

Emis, Tex., March 26.—Mr. E. D. Champion, a farmer of Oak Grove, said to a News correspondent that wheat in his community has been suffering from an insect pest, though it is coming out well since the recent rains.

[Houston (Tex.) Post, March 29.]

Sherman, Tex., March 28.—Holmes Colbert, one of the prominent Indian planters of the Choctaw Nation, was in the city to-day. Colbert has 4,000 acres in wheat and oats, and says the pest has appeared in the Indian Territory.

[Fort Worth (Tex.) Register, March 31.]

J. C. Martin, who lives at Riverside and has recently been in the northern part of the county, says that the damage there is not as great as recorded, although there are many spots perfectly bare.

D. M. Morgan, of the cotton belt, says the crop is ruined between that place and Sulphur Springs, and between Dallas and Sherman, and also between this city and Thurber. Mr. Morgan says he has saved his own crop by cultivation with a weeder.

Milt Hampton, who was in from near Crowley yesterday, said that his crop of 200 acres was so badly damaged that he turned his cattle in on it and will plow up the ground and plant cotton and some other crop.

John Day, who was in from his farm in the northern part of the county, said that he had not suffered much, but some of the crops in that portion of the county were ruined.

T. N. Bradburn returned Friday night from a week's trip up the Fort Worth and Denver road, stopping at nearly all the stations between here and Iowa Park. He says that up to a week ago the Panhandle had the finest prospects for a great wheat crop, but now the wheat has been greatly injured and in some places entirely ruined. The bugs reached Wichita Falls on Tuesday last and now there are millions of them laying waste the crops. Many fields, he says, between here and there are ruined.

[Dallas (Tex.) News, April 2.]

Denison, Tex., April 1.—W. B. Chiles, a prominent farmer living near Pottsboro, states that the grain-destroying insect is doing great damage in his section of the country. They fly about late in the afternoon. At times the air is full of them and they travel with the wind. They are now working especially on oats.

J. W. Badgett, who lives east of Colbert, Chickasaw Nation, said: "I stated last week that we had no signs of the insect, but the case has been reversed; this week we have them, and by the thousands. They seem to be concentrating on oats, but I believe that unless steps of precaution are taken, they will kill our corn before it is old enough to escape them. I have been farming a long time, but I have never seen anything like this work on grain. I am going to make an experiment Monday. I will run a harrow over my grain and then roll it with a heavy log. This will kill the insects and even if our oats are killed by the remedy, we will thereby save our corn."

[Dallas (Tex.) Herald, April 11.]

Rhome, Tex., April.—The ravages of wheat and oats insects are causing great depression of spirits among the farmers of this county. A large part of the wheat acreage

is completely ruined by the insects, while other portions are scarcely touched. Much of the wheat will be plowed up and cotton planted.

[Galveston News, April 17.]

Ennis, Tex., April 15.—Mr. George Hogg, of Telico, said to-day that myriads of green bugs fell upon his corn yesterday and covered it up, and he will begin to-morrow to plant June corn between the rows.

[Dallas (Tex.) News, April 17.]

Kingston, Tex., April 15.—The ravages of the green bug have almost destroyed the oat crop in this vicinity. The wheat crop is improving and looking better; it seems to be outgrowing the injuries of the bug. Yesterday it was warm and the bugs seemed to be on the move south. The air was thick with them during the entire day and some farmers report them leaving their fields.

Fate, Tex., April 15.—Large fields of the spring oats have been entirely destroyed by the little green bugs. Winter oats and wheat have not fared better, but can hold out longer on account of being better rooted. It was thought that the little pest would not bother the corn, but all corn is badly damaged and some fields look as if they would have to be planted over.

[Nevada (Tex.) News, April 19.]

We have interviewed several farmers this week from different parts of the county relative to the work of destruction that has been done to the small grain crop. The majority of them say that the oat crop will be a total failure and that the wheat crop at the outside will be cut short 50 per cent. The farmers say that where corn has come up that it is being attacked by the pest and will no doubt be ruined. Some few have begun to plant their corn over.

[Dallas (Tex.) Herald, April 23.]

McKinney, Tex., April 23.—The green bugs filled the air yesterday, making their exodus, leaving behind them hundreds of acres of blighted wheat and oats.

[San Antonio (Tex.) Express, April 23.]

Sherman, Tex., April 23.—Farmers from various sections of the country who were in Sherman to-day stated that green lice are still swarming. They seem to be leaving the corn, to the great satisfaction of the farmers.

[Galveston (Tex.) News, April 24.]

Fort Worth, Tex., April 23.—The executive committee of the Millers' Association held a meeting here this afternoon, and the greater portion of the time was consumed in hearing reports of the damage done to the wheat crop by the green bugs.

Henry Landa, a member of the committee, from New Braunfels, said that the damage to the large wheat counties would reach 75 per cent; and that, in Grayson, Cook, and Denton counties especially, it was reported the farmers would not make seed, and would not, in a number of the larger wheat counties, get back as much wheat as they had put in the ground. Mr. Landa thinks the situation is very unfavorable for the millers, as some will not be able to run their mills, and others will have to go out of the State to get their grain.

[Dallas (Tex.) News, April 24.]

Persons who were on the streets in certain portions of this city were vexed by the countless numbers of little bugs that clung to their clothing so tenaciously that it was almost impossible to brush them off. In some places they were so numerous as to present the appearance of an Indian summer haze.

These were the famous green bugs or plant-lice, whose ravages in this section this year have cost the farmers many and many a dollar. They were all northward bound, their departure from the grain fields being caused doubtless by the warm weather now prevailing.

Of the number that took wing for cooler regions there are probably several billions that will never raid another grain field. The English sparrows—the pest of the city—began at daybreak a war of extermination upon the pests that ended only at twilight. Twittering with delight, they sailed in flocks through the clouds of bugs, devouring all they could hold. These attacks, however, caused no perceptible diminution in numbers.

An instance of the loss caused by the lice was reported here during the day. A Dallas County tenant farmer had many acres in wheat and oats which these bugs completely destroyed.

[Houston (Tex.) Post, April 25.]

Cleburne, Tex., April 22.—The green bug is killing oats north of the city and has devastated several fields in this neighborhood.

[Dallas (Tex.) News, April 25.]

McKinney, Tex., April 24.—The News correspondent traveled over the county from McKinney to the Shain ranch beyond Celina, a distance of 22 miles; thence south along the Denton and Collin County line to the ranch of Parvin, 18 miles west of McKinney; thence east of McKinney yesterday. The devastated wheat and oat fields presented a fall-like appearance, owing to the brown color so much like stubble land. Thousands of acres will be idle this year for want of labor to replant. It is a scene of desolation in every direction in west Collin.

Denison, Tex., April 24.—James Jacobs, a farmer from the country a few miles west, says the bugs are still active and seem to breed as long as there is anything green to feed upon. He has noticed, however, that the sun kills them as quickly as their wings grow.

Sherman, Tex., April 25.—Statements from authentic sources that the green bugs are leaving in great swarms continue to come in from all sides.

[St. Louis (Mo.) Republic, April 26.]

Kansas City, Mo., April 24.—Grain men who are going over the wheat fields of Oklahoma say there is a genuine alarm entertained because of an invasion of the green bugs.

Henry Lason, of El Reno, and C. H. Stevens, of the Purcell mill, report the louse as making inroads in the summer wheat to the extent of threatening to destroy a vast acreage. The Government report shows last week the louse was confined south of Guthrie, but now it is reported nearing the Kansas line. The winter hard wheat is not attacked. Cold weather has no effect. In places the entire space in the fields attacked is absolutely dead, though wheat is knee-high.

[Fredericksburg (Tex.) Star, April 27.]

The wheat fields of Meridian have a new and destructive enemy. The farmers are very anxious about them. They fear that the wheat crop will be utterly destroyed by them. Some crops are reported as already destroyed, and the owners are thinking of plowing up the fields and planting them in corn.

The oldest inhabitants have never seen anything like them. They are about the size and shape of the mites which are sometimes seen on cabbage-stalk sprouts in the spring, but their color is a deep dark green, about the shade of the green blade on which they feed, and sometimes 6 to 8 will be found on a blade. In a few days the blade turns yellow and begins to dry up. They also abound on the winter oats.

[Galveston (Tex.) News, May 18.]

Sherman, Tex., May 17.—J. P. Harrison, president of the Texas Grain Dealers' Association, in reviewing the grain crop, said to the News reporter: "There will be no oats raised in Texas north of Waco. In Coryell and adjacent counties the reports are not quite so discouraging, and it may be that sections may produce enough to supply Texas with seed. The condition in Texas is duplicated in the Indian Territory, where the situation can be attributed directly to the green bugs. In Oklahoma the bugs did not do much damage. But for drought, which came and finished their work, Oklahoma might have had a pretty fair crop. There will be little or no wheat made. Occasionally a field is heard from that will harvest a fair yield. I can only account for it on the theory that the fields were a little forward and the stalks tough enough to withstand the bug."

[Galveston (Tex.) News, May 30.]

The small grain crop of the State will not exceed one-fourth of last year's yield. The average in wheat and oats is less and the conditions 75 per cent below the average of May, 1900. The yield is cut short owing to the early spring drought and to the ravages of the aphid or green bug. The damage by the pest, although amounting to total losses in many fields in choice grain counties, is slight compared with general damage due to want of moisture early in the growing season. The reports annexed cover 161 counties, 105 of which were free of the insect pest, while all the counties reported suffered for the want of moisture.

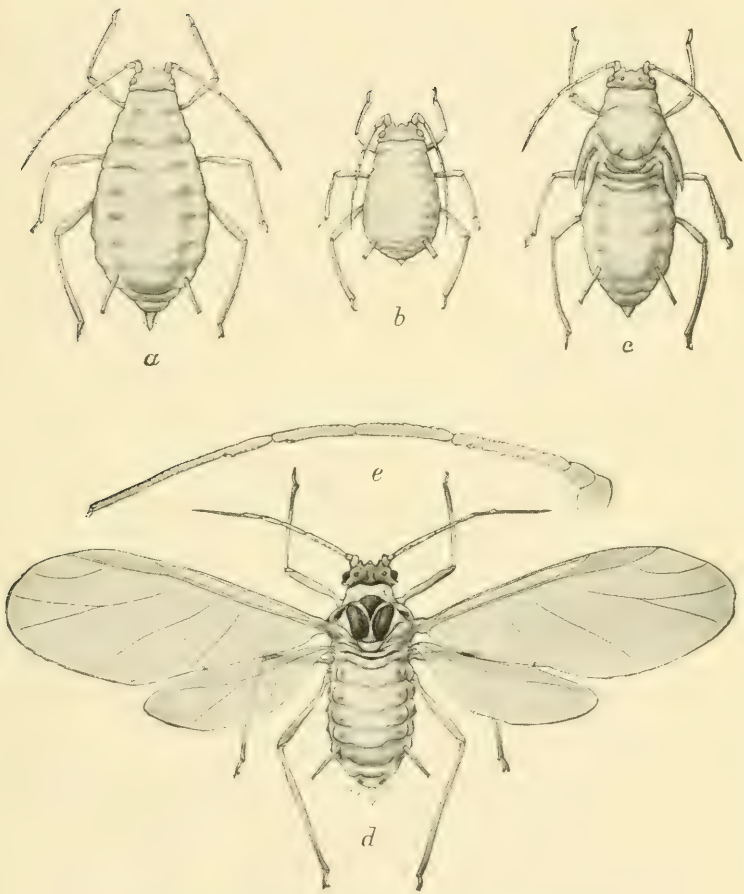
The pests appeared in numbers early in April, multiplied rapidly, were rapacious of appetite, and gluttonous without apparent satiation, repletion, or surfeit, and began to disappear in flurries in May. When the bugs attained the aerial stage they rose in a body from the ravaged field, took flight, remained on the wing for hours, and drifted with the wind. During storms they sought safety near the base of the wheat or oat blades. The farms intervening between the points of ascent and descent sustained no insect damage, but suffered from drought. The drought preceded the advent of the aphid, the 40 counties reporting "green bugs" also chronicling an early spring drought. The percentage of losses where not separately given combine the damage from both causes.

The wheat crop in the Chickasaw and Cherokee and portions of the other three nations in the Indian Territory, and in Oklahoma, ravaged by the grain louse, has greatly reduced the value of this year's crop in those Territories. In some regions the injury has been so great that farmers have preferred to replant the wheat acreage to some other crop. The louse, like its relative in Texas, is capable of very rapid multiplication, is gluttonous in appetite, and is favored by dry weather. The general trend of the migration of the insect, as in Texas, was from south to north.

GENERAL REMARKS.

In view of the overwhelming evidence as to the destructiveness of this pest to wheat and oats in the grain-producing States, it seems strange that it should have escaped notice until the year 1884.

Whether this plant-louse is indigenous to this country or whether it has been introduced from abroad is a difficult question to answer. At any rate, according to the notes of the Department of Agriculture, it was first observed in the more central section of States bordering the Atlantic Ocean, which seems to indicate that in some way it managed to reach our shores on a vessel from the southern part of Europe, entering one or the other of the ports of this central section, from



THE SOUTHERN GRAIN LOUSE (*TOXOPTERA GRAMINUM*).

a, Apterous female; *b*, larva; *c*, pupa; *d*, winged migrant; *e*, antenna of migrant—all enlarged (original).

which it managed to spread and to establish small colonies here and there on various grasses, suited to its taste, which insured it a foothold in this country and enabled it to multiply without being detected in time to adopt heroic measures for its extermination. The assumption of its foreign origin seems the more reasonable since otherwise its presence on small grain would have been observed from the earliest time that these cereals were grown in this country.

After its introduction it has naturally migrated in various directions, and established small, isolated colonies which have given it a chance to obtain a foothold and to escape observation and detection. From these centers of infection and with the assistance of air currents it would be enabled to spread unobserved to far distant sections until it reached grain-producing areas, the tender and succulent plants of which are more suited to its taste. Thus it has multiplied rapidly and spread from field to field and from State to State. Notwithstanding that millions of the migrants are killed during this flight, enough remain to stock new regions.

At the time of migration, which in the Southern States, as far as observed, takes place in May, most of the wheat and oats which escaped injury had become so tall and vigorous as to withstand attack. Possibly such growth may be unfit for the sustenance of this plant louse.

Whether the species really thrives on corn or not is an open question. Thus far it has never been received by this Department from any of the corn-growing sections. The writer is rather of the opinion that the plant-louse frequently observed on corn is the common corn aphid, *Aphis maidis* Fitch, which somewhat resembles this grain louse both in size and general coloration.

What becomes of the survivors after leaving the grain remains an unsolved problem. It seems, however, quite natural that during the warmer season, after the harvesting of the grain, they will subsist upon various succulent grasses growing in damp and moist localities, such as the borders of rivers, creeks, swamps, or similar places, and perhaps also on volunteer wheat and oats coming up in the fields. These would afford them a chance to survive and multiply until the new grain makes its appearance above ground.

As with other aphides, a sexual generation will appear at the proper time, and with it the eggs, for the preservation of the species. The great majority of our indigenous species of plant-lice produce the sexual generation during the fall of the year, the eggs of which remain dormant till the time at which a new cycle of plant life appears. A few, however, produce the sexes and their eggs during the latter part of spring or early summer, to hatch the following spring. What are the habits of this grain aphid in this respect it is difficult to say. Taking into consideration the very early appearance of the lice in

perceptible numbers on young grain, it appears probable that one or another generation, descendants of the migrants from grain, produces a sexual generation and consequent eggs on some kind of grass, which may hatch during the fall of the same year instead of the following spring, in time to produce a winged generation. This last probably re-migrates to young winter wheat, to restock it with lice, and many would undoubtedly perish during the cold and wet season, though enough of them would survive to reproduce when the climatic conditions become more favorable.

The whereabouts of the species after leaving the grain, the hiding place of the sexes and their eggs, and the reappearance on grain, are highly interesting and important questions, which entomologists of infected sections should strive to solve for the benefit of those engaged in the cultivation of small grain.

DESCRIPTION OF THE SPECIES.

Apterous female.—Length 1–1.8^{mm}; color yellowish green and slightly pruinous, the median line darker green, the head and prothorax somewhat paler than the rest of the body. Eyes black. Antennæ black, the two basal joints and more or less of the third joint at base yellowish. Legs yellowish, the tibiae brownish toward the apex, tarsi black; nectaries greenish and frequently with a dusky tinge, their apex black. Tail dusky. The general color of the larvæ and pupæ is like that of the apterous female. Wing pads of pupa dusky to black. Antennæ slender and about one-half the length of the body. Nectaries slightly tapering, reaching to or slightly beyond the end of the body. Tail slender, somewhat constricted about the middle, and about two-thirds the length of the nectaries. There is a distinct fleshy tubercle each side of the prothorax and similar tubercles along both sides of the abdomen.

Migratory female.—Expanse of wings 5–7^{mm}; length of body 1.5–2^{mm}. General coloration of the abdomen as in the apterous forms; head brownish yellow; the eyes brown; antennæ, thoracic lobes, the posterior margin of the scutellum and the sternal plate black; the two basal joints of the antennæ yellowish green; legs yellow, the femora more or less dusky, the posterior pair darkest; apex of tibiae and the tarsi black; nectaries and tail yellowish, the latter changing gradually to dusky or black toward the end; wings transparent; costa and subcosta yellow; the stigma somewhat paler, its inner edge and the veins black. Third discoidal vein with but one fork. Antennæ long and slender, reaching nearly to the end of the body, the third joint provided with 3 to 7 sensoria. Nectaries, tail, and lateral tubercles, as in the apterous females. (See Pl. I.)

NATURAL ENEMIES.

As natural enemies of this species in Europe, Rondani mentions *Scymnus 4-pustulatus* Fab., a small Coccinellid or ladybird, the adult and larvæ of which feed upon the lice; *Paragus coadunatus* Rondani, a two-winged Syrphid fly, whose larva preys extensively upon all kinds of plant-lice; and a minute hymenopterous insect, *Aphidius aphidum* L., a true internal parasite.

Of the most effective predaceous insects which have been observed to feed upon this grain aphidid in the infested regions of the United States, the following may be mentioned: Two ladybirds, *Hippodamia*

convergens Guér., and *Coccinella 9-notata* Hbst., both of which, in the adult as well as in the larval state, feed ravenously on the lice, though the larvæ are frequently suspected by grain growers of being the parents of the lice, especially if found to be numerous in infested fields; and larvæ of various Syrphid flies and Chrysopids or lacewing flies, which are even more voracious than those of the Coccinellids.

Many of the lice are also killed by the larvæ of a small and slender black internal parasite, *Lysiphlebus tritici* Ashm., which preys upon various species of plant-lice, frequently killing within a short time large colonies. The larva of this does not leave its host, but transforms within the puffed up and empty shells of the aphides, many of which may readily be observed adhering tightly to the stems or blades of the grain. The little parasite, when ready to leave its host, cuts out a neat circular piece, generally near the end of the body, and through the opening it escapes.

METHODS OF CONTROL.

Owing to the practical impossibility of applying kerosene emulsion or similar washes so as to destroy insects which develop on standing grain, particularly such as feed by suction, we must look to other methods for the successful treatment of this plant-louse. Three or four other forms of plant-lice usually occur in more abundance than the species under discussion, and it has been found by experience that these, as well as the present species, are very largely controlled by natural conditions, sudden changes in the atmosphere, and such parasitic and other natural enemies as have just been considered. Lady-birds and fungus diseases are the most important factors in reducing the numbers of this pest. The year 1901 was particularly favorable for the multiplication of this plant-louse in Texas, but, as usually happens, the cool, moist weather of early spring, which favored the increase of the pest, was followed later in the season by a sufficient period of dry and sunny weather to enable the natural enemies, nearly all of which are most active in such weather, to gain the ascendancy, and this they did, practically exterminating the lice in the region affected. It should only be necessary to add that most other species of plant-lice are controlled in precisely the same manner, and it is seldom that they are destructive for more than one or two seasons in succession. Examples are to be found in the cabbage louse, melon louse, and the destructive green pea louse, which was such an enemy to the pea industry throughout the more northern portion of our country during the years 1899 and 1900, from the Atlantic coast to Wisconsin. This last insect practically disappeared as a pest during 1901, and up to the date of writing has only appeared in numbers in a few isolated localities, so far as we know, in the District of Columbia and immediate vicinity.

REPORT OF AN INVESTIGATION OF DISEASED COCOANUT PALMS IN CUBA.

By AUGUST BUSCK.

In August, 1901, I was instructed to proceed to Habana, Cuba, and report to the military governor there in order to investigate a disease which threatened the cocoanut industry in the province of Santiago.

In accordance with instructions, I left Washington August 7 and, arriving in Havana on the 10th, reported in the palacio to the adjutant-general, Col. J. H. Scott. The same day I sailed with his instructions for Baracoa, on the northeast corner of the island, arriving there August 14. The country around Baracoa is the only remaining cocoanut region of importance in Cuba, and the industry is the main support of that part of the island, from which large shipments of great value are annually exported to the United States.

The country of that region is mountainous, rough, very fertile, and picturesque with palm-covered mountain sides, deep valleys, and large rivers. There are no wagon roads, and travel is on horseback along narrow and often difficult trails.

There were no diseased palms in the immediate neighborhood of Baracoa, but going out some 10 miles east along the coast, yellow, drooping tops and naked trunks began to appear, and still farther out around Mata and neighboring towns the disease reached its highest development. Here large areas were attacked, and already from 10 to nearly 100 per cent of the trees were lost. Serious damage was quite evident, and the lamentations of the natives and their anxious inquiries as to how to save their sole property were most natural.

The first outward indication that a palm is attacked is the falling of the young fruit; shortly afterwards the larger nuts drop and the leaves assume a pale yellowish color.

Within a month all the large lower leaves droop and fall, leaving the pale, sickly tops, which at the first heavy wind blow over and then only the naked trunks stand as ghastly tombstones where a few months before stood graceful valuable palms. Palms of all ages are subject to this disease, though it seems more prevalent among the older plants.

On felling a palm and examining it, it is apparent that the trouble is not found in the root or main part of the small trunk. From the root upward to within a few inches from the top, the trunk may be fresh and sound with practically no insect of any kind and with no fungus mycelium. Just below the top and in between the bases of the leaves was found in nearly all of the three hundred odd palms in different stages of disease, which were cut down during my investigation, the galleries of scolytids or ambrosia beetles (*Xylchorus* spp.), rarely, however, in such numbers as to arouse suspicion of the beetles being the cause of the death of the palms.

In and around these holes and perforating the entire upper part of the trunk for 2 to 10 inches downward was found the mycelium of a fungus, the fruiting bodies of which came forth as small white spots on the under sides of the leaves and which might easily, on hasty examination, be confounded with *Aspidiotus* scales which were often found there.

This parasitic fungus has been identified by Mrs. F. W. Patterson, mycologist, and Mr. A. F. Woods, pathologist, of the Department of Agriculture, as *Pestalozzia palmarum* Cooke. They inform me that though they have no record of the particular damage, "it is extremely probable that this fungus is the cause of the diseased condition of the trees," as they have records of similar causes in other trees.

Breaking off the lower leaves and cutting the center of the green growing part open, the heart of the palm is found to be one putrid offensive-smelling mass, filled with maggots of various scavenger flies. By examining palms in various stages of sickness, it was found that the putrefaction began within the sheath around the young still unfolded flower stalks and gradually worked downward to the center of the plant, and while the primary cause of the death of the palm undoubtedly is the fungus, the nature and foul smell of the diseased parts seemed to indicate some bacteriological influence, when the palm is already weakened by the fungus and doomed to die.

In from one to three months after first attack full destruction takes place and the trunk stands naked, and though it is still fresh and apparently sound, it soon disintegrates through the work of termites or white ants and other insects.

The fatal nature of the disease precludes a remedy for trees already infected and leaves only the prevention of the spread of the disease as the object for man's intervention.

As the most natural means of preventing the spread of the disease, the cutting down and burning up of the diseased palms suggests itself, and Mr. A. F. Woods agrees that this is one of the best ways of combatting it. In a small and necessarily incomplete way I satisfied myself of the practical results of this preventive. Shortly after my arrival I observed one large grove with only two isolated dying palms. These I had cut down at once and removed the infested parts to my headquarters for examination. During my entire stay no more palms in that grove showed signs of disease, although in other tracts with sick palms left standing new cases of infestation were observed in numbers every week.

The procedure of felling and burning many palms may seem too enormous an undertaking, but considering the interests at stake it is a small matter and comparatively easy of execution.

Without such drastic measures the present conditions and the rapid spreading of the disease certainly foreshadows total destruction of the

cocoanut industry, a very serious matter for the population of that part of the island of Cuba.

It is not necessary to burn the entire trunk, which would involve extra labor, but only the top with a couple of feet of the upper end of the trunk.

But it is necessary to have united action in order to make the remedy of any real value, as it is evidently futile for the proprietor of one estate to eradicate the disease within its limits if the owners of neighboring estates omit the precautions and allow the disease to multiply and send its spores abroad to the others. I therefore suggest local legislation, which would make it compulsory on every owner to cut down palms as soon as they show infection and have the diseased parts burned; and, furthermore, that some trustworthy, intelligent man be constituted inspector with the duty to inspect weekly the entire region and with power to have cut down at once and burned at owner's expense any sick palm found omitted.

Such action, together with advice to plant new cocoanut palms, will, I fully believe, save the greater part of this important industry, which otherwise seems doomed to annihilation.

The insects found to be connected with the cocoa palm in this Baracoa district were few and all of secondary or of no economic importance. The only ones which may form an exception are the Scolytids (*Xyleborus* spp.) through the holes of which the fungus doubtless gains easy entrance to the palms. These beetles are not always present and evidently do not constitute the only means for the spores to reach their destination. It is not impossible that they are altogether innocent and merely come after the weakened condition of the palm, as Mr. E. A. Schwarz suggests is probable. But as carriers of the spores from palm to palm these insects and numerous scavenger flies which are attracted to the sick palms may be of importance. The most common of these are the striking, beautiful metallic-green *Tolucella obesa* Fab. and the curious long-legged *Calobata nebulosa* Loew.

On the underside of the leaves and on the green fruit was found quite commonly, but never in dangerous numbers, the destructive scale insect, *Aspidiotus destructor*, which everywhere in that region was kept well in check by the black, red-spotted ladybird, *Chilocorus cacti* Linn.

A large beetle, *Stratægus titanus* Fab., was often found among the flowers of the cocoas and was invariably accused by the natives of being the cause of all the trouble, while in reality it did little or no harm in eating the pollen and possibly the tender shoots. The larva lives in decayed wood.

Of the palm weevil, *Rhynchophorus palmarum*, which before my trip was suspected as being the possible cause, not one was found and no other borer than the Scolytids previously mentioned.

The long double rows of egg-holes of the large *Cicada bicosta* Walk. were quite commonly found on the undersides of the stalks of the lower leaves, but the damage is insignificant.

THE PALM AND PALMETTO WEEVILS.

By F. H. CHITTENDEN.

As in a measure supplementary to the report of an investigation conducted by Mr. August Busek, of this office, on diseased cocoanut palms in Cuba, due to the fungus, *Postaloizia palmarum* Cooke, but supposed to have been caused by the palm weevil (*Rhynchophorus palmarum* Linn.), the following account of that species and the palmetto weevil (*R. cruentatus* Fab.) has been prepared. It is somewhat singular that at the time Mr. Busek was prosecuting this investigation the palm weevil was not once encountered, but the palmetto weevil was doing injury to the date palm in Florida. The latter, although well known, has not attained any prominence as a pest, but we have an extensive account of the palm weevil by Mr. W. F. H. Blandford, published originally in the Kew Bulletin of February-March, 1893 (pp. 27-60).

THE PALM WEEVIL.

(*Rhynchophorus palmarum* Linn.)

With the establishment of the growing of cocoanut palms in British Honduras, the ravages of the palm weevil seriously discouraged that industry. In the year 1888 the government of that country, becoming cognizant that the losses apparently resulting from the palm weevil menaced the prosperity of the colony, appointed an investigating commission, the result being the publication of the article above cited. Until the injurious occurrence of this species in British Honduras, the palm weevil was better known to the public as the parent of the "gru-gru" worm, which was eaten by the natives of Central and South America, and mentioned by most writers of early times as "being considered a delicacy." On this head Mdlle. Merian, in her "Dissertation sur la Génération et les Transformations des Insectes de Surinam," etc., published in 1726 (p. 48), wrote as follows:

The Dutch name it Palmyt-Worm, that is, the Worm of the Palm, because it feeds on that tree. In the trunk of the palm tree, swarm certain worms feeding on the pith. At first no larger than cheese-maggots, they grow like the one here represented. Certain folk grill them, and consider them a most savory morsel. From this worm comes a black beetle, such as I have depicted, which the Indians and the Dutch both call the *Mother* of the palm worm.

The next article of importance bearing upon this species is entitled "Insects infesting the Sugar-Cane." It was written by Rev. Lansdown Guilding, and published in 1828 (Trans. Soc. Encour. Arts, LXVI).

Through the kindness of Prof. M. E. Peck, Iowa Falls, Iowa, we have received some information relative to this same insect and its injuriousness to palms in British Honduras. Under date of January 1, 1902, he writes that during several months' stay there he became considerably interested in the cocoanut industry, and especially in the methods in use for meeting attacks of this palm weevil and other beetles infesting the cocoanut. Numerous plantations were reported to be seriously injured or wholly ruined by these insects, which are considered the chief drawback to the industry in that region. One grower, Mr. John T. Seay, of Manatee District, British Honduras, succeeded to some extent in conquering these pests. Mr. Seay had a plantation about 20 miles south of Belize and extending for 3 miles along the coast. His trees were in flourishing condition, ranging in age from two or three to fifteen years. Mr. Peck examined the larger part of the adult trees and found that nearly half of those with trunks over 6 feet in height had been attacked by the weevils, but had been successfully treated and the insects destroyed. Mr. Seay's method of treatment was described as so easy and rapid that one man could attend to many thousands of trees at very slight expense. He stated that if these beetles were as destructive in our newly acquired tropical territory (according to present accounts they are not) as they are in Central America, it would certainly be worth while for the Department of Agriculture to inquire into the matter.

Mr. Seay was written in regard to his experiences, and he answered January 22, and later in 1902, giving much information concerning this and other insects associated with injury to palms cultivated in British Honduras. His acquaintance with this weevil dated back about thirty years, and for half of that time he had been studying its habits in order to be able to use his knowledge to advantage in the application of remedies.

ASSOCIATES OF THE PALM WEEVIL.

The associates of this weevil, specimens of which accompanied other material, were a large shining black Histerid beetle (*Hololepta quadridentata* Say), a large dipterous larva or maggot, which proved on rearing to belong to the tachina fly, *Willistonella pleuropunctata* Loew, an Orthalid, *Epiplatia crosa* Wied., and two forms of mites identified by Mr. N. Banks as belonging to the genera *Uropoda* and *Holostaspis*. The latter mite was observed singly in the material furnished us on both the weevil and the Histerid sheltering in clusters on the hairy portions of the under surface of the weevil and more especially on the tibiae, although also clustered on the abdomen and prosternum. There is no doubt that these mites are of some value in destroying the weevils in their different stages, more particularly, perhaps, when in the pupal stage, if they have opportunity to penetrate

the pupal cells. Histerids are, as a rule, predaceous, at least in the larval stage, and these may also do some good by destroying the eggs and young of the weevil when the latter are first hatched.

Rhina barbirostris Fab.—June 19, 1902, we received from Mr. Seay, through Mr. E. J. F. Campbell, superintendent of agriculture, botanic station, Belize, Honduras, specimens of this large weevil, with the expression of opinion that, first of all, the cocoanut trees were in a more or less unhealthy state when attacked by it and that it did no harm to healthy trees; but some injury must in the first instance happen to some part of the plant, stem, roots, or leaf, to cause a flow and subsequent fermentation of sap to attract the insect.

The *Ambrosia* beetles (*Xyleborus* and *Monarthrum* spp.) bore into the cracks of the stem of the injured plants; and the palm weevil (*Rhynchophorus palmarum*) follows. The ambrosia beetles make holes in the trunk and bore straight ahead, the size never increasing, and throw out sawdust, which the weevil does not usually do. The latter makes a small hole and inserts an egg which hatches into a grub, and the grub excavates cavities which constantly increase until finally it forms its cocoon.

AS TO WHETHER INSECTS ATTACK HEALTHY OR ONLY SICKLY TREES.

The belief is quite prevalent in British Honduras that the palm weevil is the chief cause of the great damage to cocoanut trees in that colony. Mr. Seay is of the opinion that the ambrosia beetles are more responsible as conveyers of disease than the palm weevil. Mr. Campbell states that the disease locally known as "fever," presumably due to the fungus *Pestalozzia palmarum*, or a similar species, is the sole forerunner of the trouble. He supposes it to be conveyed from unhealthy trees growing in unsuitable ground. On this head he expresses himself substantially as follows:

From my own observation I am of the opinion that cocoanut trees are never attacked by weevils unless the plant is more or less in a sickly condition—a fever of some kind. This fever may originate from different circumstances, such as sudden cold weather, excessive wet, causing water to lie around and affect the roots, the want of good drainage, inferior soil, sudden exposure of the stem to the direct rays of the sun, or other conditions due to planters neglecting to clean their trees for months or years. * * *

He is convinced that "no fly, bug, or weevil" will attack a perfectly healthy cocoanut tree that receives proper attention by its owner.

THE PALMETTO WEEVIL.

(*Rhynchophorus cruentatus* Fab.)

September 10, 1901, we received specimens of this species in the grub state from Mr. Lee Mulford, Fort Ogden, Fla., that had been taken from a 10-year-old seedling date. The entire trunk was found

to be honeycombed, and fifty or more of the grubs were observed. They were stated to be quite active and capable of traveling some little distance, and to be noisy when at work, making a sound like the escape of water with an occasional screech like a choked hen.

April 4, 1902, Mr. W. F. Fiske, Atlanta, Ga., sent fragments of this beetle, taken from its cocoon in the trunk of *Sabal palmetto*, the tree having died and the crown fallen. Other trees in the neighborhood were killed and some showed evidence of attack.

DESCRIPTIVE.

The beetle.—The general appearance of the beetle is shown in figure 1, at *a*. The thorax, and frequently the elytra, are usually more or less reddish; sometimes both are decidedly red, marked with black spots which form a pattern more or less like that depicted. The under surface is also partly red and partly black, but frequently specimens are met with which are entirely black, some decidedly polished, and

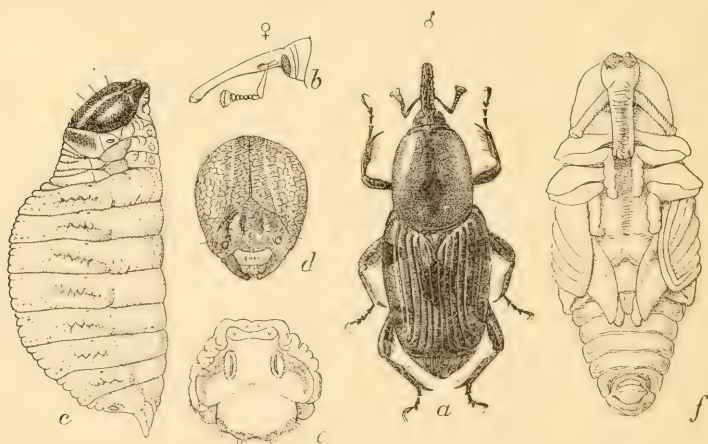


FIG. 1.—Palmetto weevil (*Rynchophorus cruentatus*): *a*, male beetle; *b*, head and appendages of female from side; *c*, larva; *d*, head of same; *e*, last ventral segment seen from above; *f*, pupa—*a*, *c*, *f*, slightly enlarged; *b*, *d*, *e*, more enlarged (original).

others dull and velvety. The body above is depressed and, as with other weevils, the head is prolonged into a snout, which is comparatively short and very rough in the male, while in the female it is longer and more slender and almost perfectly smooth along the upper surface. (Compare *a* and *b*, fig. 1, the latter a side view of the female head with snout and antenna.) The antennae are geniculate or elbowed, as in most curculios of this group, and the last joint is strongly expanded. The elytra, or wing-covers, are deeply striate or furrowed, as shown in the figure. The legs are fringed on the inner surface with long reddish-yellow hairs, and the tip of the tibia bears a long apical spur and two shorter teeth. The length, exclusive of the snout, measures from eight-tenths of an inch to upward of an inch and an eighth. A technical description is furnished on page 408 of Dr. Horn's paper entitled "Contributions to a knowledge of the Curculionidae of the United States." (Proceedings American Philosophical Society, 1873.)

The larva is shown in figure 1, at *c*. It very closely resembles that of *R. palmarum*, which is figured in both the articles of Messrs. Guilding and Blandford. It is of robust form and somewhat different from any other rhynchophorous larva that has

ever been under observation by the writer. Its color is rather pale yellowish-brown, with exception of the first thoracic segment, which is chitinous, and the head, which is dark brown. The latter is illustrated at *c* (fig. 1). It will be noticed that the eyes compose a large proportion of the head, and are divided into irregular areas. As will be seen in the illustration, the segments are quite distinct, and there are 9 spiracles, including 8 abdominal ones. The length, when in somewhat retracted position, is about $1\frac{1}{4}$ inches. In many respects this species resembles that of *R. palmorum*; hence a detailed description is scarcely necessary, as nearly two pages have been devoted to the description of that species in Blandford's article previously quoted. It should be stated, however, that Horn, quoting LeConte as authority, says that these stigmata are completely absent, because neither of these specialists had an opportunity of observing fresh alcoholic specimens, and drew their deductions from "a carefully prepared skin."

The pupa (fig. 1, *f*), in specimens which the writer has had under observation, is of a similar color to the larva, and is noticeably larger than the beetle, a rather unusual matter with pupæ, but readily accounted for because the pupa is necessarily rather delicate, while the beetle is decidedly hard like all of its kind and quite compact. The length of four pupæ before the writer afford an average of $1\frac{3}{8}$ inches. This species appears to be most abundant in Florida, but is recorded as occurring from South Carolina to Louisiana.

REMEDIAL TREATMENT.

Owing to the somewhat peculiar habits of these weevils and their resistance to poison, we can not treat them by any single method, but must employ several, both cultural and mechanical. Perhaps one of the best preventives that has been suggested consists in cutting down or wounding several young trees or wild species of palm or palmetto which may be found growing in the vicinity of the date or cocoanut trees to be protected. The sap which exudes from the dead or wounded trees ferments and acts as a strong attraction to the beetles. Frequently a multitude are thus attracted and can be captured without trouble and killed before they have had time to oviposit. The trunks of felled trees soon become filled with larvæ, and infected portions should be sawed off and burned before the insects mature, leaving the remainder of these trunks to act as traps for other insects. It is also recommended that care be taken in the choice of sites for new plantations, undue proximity to what is known as a "cohoon" ridge being avoided, and that all stumps and felled trees not used as traps be promptly destroyed. Thorough drainage and wide planting are also advised. The trees should be left as far as possible in a natural state and unnecessary trimming should be avoided. Wounds might be dressed with any mixture that would deter the beetle from attacking them and prevent fermentation, such as tar or grafting wax.

The beetles can easily be killed by dropping them into hot water.

Some of the remedies above described were first suggested by Mr. Blandford (*loc. cit.*) and others by this Division.

Mr. Seay is most successful in the treatment of the palm weevil by the use of traps, which have been in use for many years by himself

and others, both against this species and related ones. The traps he uses are mostly what is termed the cabbage portion of the palm while it is fermenting. When fresh cut, the "cabbage" will attract the weevils somewhat, but when it reaches the vinous stage it emits a powerful odor, which the insects can detect from a great distance. They soar about for a while, then alight and proceed to work. After feeding for some time, they look about in search of a "nice heap of rubbish to hide and sleep in, but if no suitable place is close, they fly away. The idea of a handful or two of rubbish catching them took me five years to find out," says Mr. Seay. "I kept trying everything I could think of to hold them, but as soon as the vinegar fermentation sets in, the weevils stop coming and the yellow bugs [ambrosia beetles] come; also several kinds of flies." When the putrid stage arrives, Mr. Seay destroys his traps. The "salt-water pimento" is the palm most used, and one or two cuts of a machete an inch or an inch and a half above the "cabbage" takes off the top, and with the point of the machete a hole is opened into the "cabbage," breaking it a little. Then the trap is set. The odor arising from these bruises attracts the insect in the vicinity, and the weevils enter the holes and also stow themselves in the leaf-stalks. In the afternoon of the following day until 2 or 3 o'clock our correspondent states that he frequently obtains half a dozen or more in such a trap. The trap lasts a week or two. When the trap has been thus used, it is cut off below the "cabbage," and the scraps are burned or thrown into the sea.

There seems little doubt that all of the flying species of insects—the weevil, the Histerid, and the two-winged flies—whose larvæ were received are instrumental in spreading the disease or so-called fever which attacks palms grown both in British Honduras and in the West Indies. Mr. Seay is unfortunate in having neighbors who also grow palms and who do not take the pains to employ remedies against the weevils. He states that 3 or 4 miles is no distance for the insects to fly in search of a sickly tree or one that is beginning to bear fruit, because then the bark is soft and the sun will make cracks and the sap oozes out in quantities, which is liked by all of these pests.

NOTES ON THE RHINOCEROS BEETLE.

(*Dynastes tityus* Linn.)

By F. H. CHITTENDEN.

Few insects attract greater attention when they occur in any numbers than the giant Scarabæid known as the rhinoceros beetle, *Dynastes tityus* Linn., sometimes called the spotted hornbug. In former years it was tolerably abundant in the vicinity of the District of Columbia, and is still to be found quite frequently in neighboring portions of

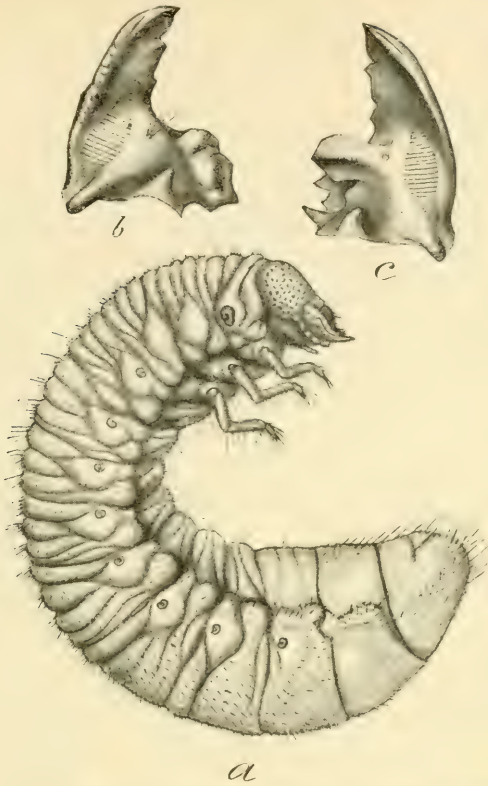


FIG. 1.—*a*, Larva (natural size); *b*, *c*, mandibles of larva (enlarged).

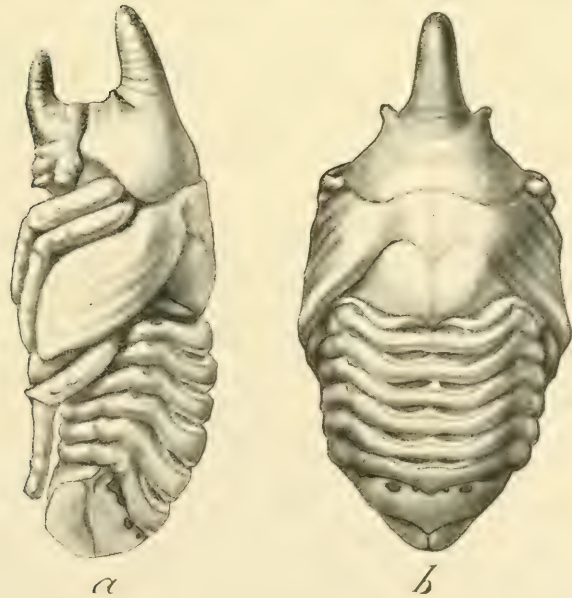


FIG. 2.—Pupa: *a*, lateral view; *b*, dorsal view.

RHINOCEROS BEETLE (*DYNASTES TITYUS*).

Virginia, and more commonly southward. It was not until the year 1891 that any considerable information regarding the insect's earlier stages was published. In that year Dr. J. A. Lintner published in his Seventh Report on the Injurious and Other Insects of the State of New York an extensive account (pp. 246-255), which included detailed descriptions of the larva and pupa by Mr. E. A. Schwarz, of this Division, with figures prepared in this office under the direction of the late Dr. Riley. These illustrations, not hitherto used in departmental publications, are now used as an accompaniment to the present notes, which add somewhat to our knowledge of the life history of this our largest and most striking native beetle.

Recently Dr. A. K. Fisher, of the Biological Survey of this Department, furnished the writer with a pair of this species from Sandy Spring, Md., and from these July 16 we obtained the egg and later the young larva. As this stage has not hitherto been described, the following description is submitted with other notes:

DESCRIPTION OF THE EGG AND YOUNG LARVA.

The egg of *Dynastes titus* looks precisely like a very small bird's egg. It is one of the largest insect's eggs that the writer has ever seen, measuring upward of an eighth of an inch at its widest diameter. In outline it is broadly oval and perfectly symmetrical, of firm consistency, and quite elastic. It is of a dull cream color and without polish or visible sculpture. The length of a freshly deposited egg is a little more than $\frac{1}{8}$ inch (3.5^{mm}), and the shorter diameter 3^{mm}.

The newly hatched larva is nearly a counterpart of that of *Lachnosterna* and related white grubs, being about double the size and width of that of *Lachnosterna arcuata*, which was figured and described by the writer on pages 74 and 76, respectively, of Bulletin 19 (n. s.), of this office. These differences, however, are observable: The head is larger, more globular, darker brown in color, and of firmer consistency, being more strongly chitinized than that of *Lachnosterna*; the mandibles are proportionately shorter and less sickle-like, and the teeth are nearly the same on both sides, the single tooth being placed nearer the tip of the mandibles. [In *Lachnosterna fusca* there are two teeth on the left side, near the base of the mandibles, and only one tooth on the right side.] The legs are proportionately shorter and the pubescence longer.

DESCRIPTIONS OF LATER STAGES.

For the benefit of those who have not seen this species, the accompanying illustration of the male is furnished, slightly enlarged, in figure 2. It measures from $2\frac{1}{4}$ to $2\frac{1}{2}$ inches from the tip of the horns to the end of the body. The female is similar, but is unarmed with horns. The general color above is a pale bluish gray in life, and the

elytra, or wing-covers, are marked with darker irregular spots similar to those on many kinds of birds' eggs. The ventral surface is a bright mahogany brown, and moderately hairy.

The larva, shown in Plate II, figure 3, at *a* in natural position, is of the usual curved Scarabæid form, dirty yellow or yellowish white in color, measuring when mature upward of 5 inches in length when extended. Enlarged illustrations of the mandibles are shown at *b* and *c* of the same figure.

The pupa is light brown in color and covered with a very fine velvety pruinosity. The male is illustrated in Plate II, figure 2, *a* showing a lateral view and *b* the dorsal, natural size.

The peculiar odor of the beetle is shared by larvæ and pupæ and lasts long after death, preserved specimens seeming never to lose this strange scent, which also remains for years in the insect boxes in which the beetles have once been kept.

In the reports of Dr. Lintner rather full bibliographical references can be found.

DISTRIBUTION.

The exact distribution of this species has never been defined, hence the following list of localities from which specimens have been sent by correspondents of this Department together with some recorded localities should be of interest, this beetle being so well known to collectors of insects:

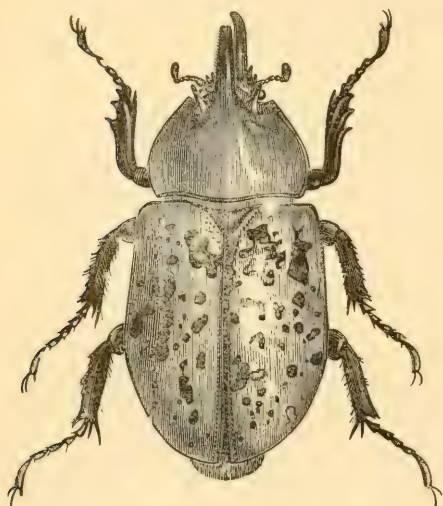


FIG. 2.—Rhinoceros beetle (*Dynastes tityus*): male—slightly enlarged (after Riley).

York County, Marietta, Lancaster, Wrightsville, Pa.; Cape May, Wildwood, N. J. (Smith); Baltimore, Hughesville, Sandy Spring, Centerville, Md.; Washington, D. C.; Amherst, Sewells Point, Bonney, Perrowville, Gills, Friedens, Coffee, Culpeper, Warren County, Va.; Wilkesboro, Raleigh, Happy Home, Fayetteville, Hooverhill, Greensboro, Asheville, Laurelbranch, N. C.; Coozan, Coronaca, Beaufort, Winnsboro, Pomaria, S. C.; Molino, Liveoak, New Smyrna, Archer, Fla.; Smithville, Pearson, Albany, Ga.; Florence, South Calera, Birmingham, Mobile, Selma, Ala.; New Orleans, Cypress, Gansville, La.; Covington, Memphis, Claiborne County, Tenn.; Ojo Caliente, Grafton, N. Mex.; Louisville, Scottsville, Ky.; Hackett City, Ark.; Paoli, Columbus, Ind.; Missouri.

BIOLOGIC NOTES.

The date of deposition of the egg was not ascertained, but was about July 18, or a few days before. When examined a week later it was

found to have grown half a millimeter in diameter by a process of absorption well known in eggs of the beetles of this family.

The exact duration of the egg stage could not be observed, but it was at least sixteen days and probably longer, the weather for this period being a little warmer than normal.

Several years ago the writer received from the late George D. Bradford, at that time traveling in the South, a number of larvæ of this species collected in the spring at Beaufort, S. C., from which material some interesting observations were made.

For several weeks after the receipt of these larvæ they did not manifest any signs of feeding, but later in July and August they ate freely of the mold or dead woody matter in which they were sent. There was originally over a gallon jar full of this mold, and as that in the jar was consumed, the remainder, perhaps a quart, was added. Three larvæ were kept in this, and almost the entire contents had become consumed and converted into pellets, resembling on a small scale those of a goat or rabbit, when the larvæ became full fed. They ceased feeding during the third week of August and remained for a few days as if resting, then went to work to form cells for the pupal transformation. When larvæ are disturbed they roll over and over, like the larvæ of many other Coleoptera and some other orders of insects, and the same motion was continued by the pupa. By this motion, in time, the interior of the pupal cell is rolled quite smooth.

August 27 the skin was noticed to be shriveled, and on the following day this increased. On the 29th all three pupated. One was still white toward evening, the other brown. Transformation to the imago occurred on the 20th of October, all undergoing this metamorphosis the same day. This gives a pupal period of fifty-one days, probably the longest warm weather pupal period of any of our Coleoptera.

The pupal cells were coated externally with excremental pellets and bits of rotten wood, and showed an average measurement of from 2 to 3 inches in length and $1\frac{1}{2}$ to $1\frac{1}{4}$ inches in width.

Hibernation takes place normally in the beetle state, and the beetles obtained in this instance were kept until some time in July of the following year, when they died during the writer's absence.

The rhinoceros beetle seldom occurs in such abundance as to be reckoned a pest. According to Dr. Lintner, however, the beetles are sometimes capable of injuries of considerable importance. He states (Fifth New York Report, p. 230), on the authority of Mr. J. W. Murrell, Perrowville, Va., that numbers of the beetles were observed feeding on the tender shoots of spring growth of ash trees, causing the leaves to fall and cover the ground as if a frost had passed over them. Their food consists largely of sap, which flows from the plants attacked. Beetles may be attracted by bruising ash twigs.

The beetles are sometimes troublesome on account of their strong and disagreeable odor.

Ash, although evidently the favorite, is not the only food plant of this species. The larvæ are probably not particular, as they live upon decaying wood and have been found feeding in decayed wood of cherry, willow, oak, and other trees.

During June, 1898, we received a specimen of this species from Mr. W. W. Thompson, Smithville, Ga., with the statement that it had been found eating a pear, an unusual food habit, judging from records.

In writing of the noise produced by this species when alarmed, the late Dr. John Hamilton says (Can. Ent., Vol. XVIII, p. 112):

While no real stridulating organs are present, they have the power to produce a sound that may answer the same purpose, somewhat resembling that of an angry goose. The pygidium and part of the last ventral segment are very hairy, and by withdrawing the abdomen from the elytra so as to admit air, and then suddenly forcing it out through the hair by a sudden extension, a noise is produced that is rather alarming to one unacquainted with their harmlessness.

NOTES ON ENEMIES OF MUSHROOMS AND ON EXPERIMENTS WITH REMEDIES.

By AUGUST BUSCK.

During the winter 1901-2 four enemies of mushroom culture came under observation: (1) snails, (2) roaches, (3) maggots of some undetermined Diptera (not bred), and (4) mites.

(1) Against the snails was used with perfect success the old remedy of trapping them under loose boards.

(2) The roaches (*Periplaneta americana*) were quite troublesome, but were at least temporarily driven away by the pyrethrum and bisulphid of carbon experiments, employed against the mites and mentioned below.

(3) The maggots, which in the cases under observation were scarce and of small importance, were not bred. They worked in the fruit bodies of the mushroom and of course spoiled such individual mushrooms as were infested. Possibly the experiments with all kinds of insecticides, conducted against the mites, killed the majority of adult flies, and thus prevented egg laying and consequent injury.

Reports from other places show that certain flies (*Phora* spp. and *Drosophila* spp.) may be very dangerous enemies of successful mushroom culture.

The present experiments tend to show that the screening of all windows or beds where feasible, and the liberal use of pyrethrum, are effective preventives against these pests.

(4) The only truly important and at the same time the most pernicious and difficult enemy to handle which has come under my observation hitherto is the very prolific and astonishingly destructive mite, *Tyroglyphus lintneri*.

It attacks the fruit bodies in all stages, thereby making these unsightly and unsalable. When present in large numbers it actually eats big holes right through them. It not only attacks the fruit bodies, but even feeds on the mycelium underground, thus destroying the plant entirely.

Many cases where beds have not yielded at all, and where the blame has been credited to "old and dead" spawn, are doubtless truly the results of this pest, which being so small has escaped notice.

In two or three cases where the failure of a bed was attributed to poor spawn, it was found on investigation that the "brick" had been all right and had begun sending out mycelium under favorable conditions, but that myriads of these mites in the ground actually consumed it as fast as it grew. In some beds they were so numerous that they covered the surface entirely, and any such bed might as well be given up at once, and the danger to surrounding beds somewhat minimized by the killing of all the mites. This may be done by pouring boiling water on the bed, using enough to reach the bottom and soak the bed thoroughly.

The following remedies were thoroughly experimented with and none proved of much value:

(A) *Bisulphid of carbon*.—Some twenty-odd beds, 3 by 6 feet, and two beds, 5 by 10 feet, were under observation in two different places. These beds were originally prepared with these experiments in view, and the boxes were made $1\frac{1}{2}$ to 2 inches higher than is usually necessary, so as to leave that much space above the ground. In other respects the beds were prepared in the usual manner, the spawn was put in, and in due time mycelium developed and mushrooms appeared.

As soon as the mites put in their appearance (they were probably brought in the adolescent stage with the manure) the bisulphid of carbon was applied. From one-fourth of a pound to 1 pound was poured into each of three or four shallow receptacles placed on top of the bed, and the whole was then tightly covered with heavy oilcloth.

This was done in the evening and the bed left overnight till the next noon, when the soil was examined.

It is possible that some of the mites had perished from the effect of the poison. Several were found dead or dying, but many more specimens crawled upon and in the soil as lively as ever and apparently not the least harmed.

The treatment was repeated next night on some of the beds, and for several nights on other beds, but with the same very doubtful success.

A number of living mites were placed in a vial on a bit of mushroom and the vial closed with cotton saturated with bisulphid of carbon. After two days several mites were still alive, and the cause of the death of the others may as well have been lack of moisture or injury in handling them as the bisulphid of carbon.

One thing was ascertained through these experiments, namely, that the mushroom mycelium is not injured by the treatment with vapors of bisulphid of carbon; in fact, the growth seemed rather stimulated if affected at all, and such beds, when not ultimately killed by the mites, produced as good a crop as those not treated. The fruit bodies above ground, however, can not stand the treatment, but disintegrate very soon, for which reason all should be plucked before the application.

(B) *Pulverized sulphur* was applied liberally with a blower, and mixed with about 1 inch of the top soil by means of a rake. Aside from such mites as were injured in the handling, and such as were actually buried in the sulphur, from which they had difficulty in extricating themselves, none seemed in the least affected.

(C) *Vapors of sulphur*.—The burning of chips of sulphur in proper receptacles on top of the beds did not have any apparent effect on the mites.

(D) *Pyrethrum powder* applied liberally with bellows had no serious effect on the mites, though they evidently did not like it. It did not seem to act even as a deterrent in such beds as were little or not at all infested. However, the undoubted beneficial results against roaches and flies, which might otherwise have become serious factors, would warrant the use of this insecticide freely in all mushroom beds as a good precaution.

(E) *Hydrocyanic-acid gas*.—Conditions did not allow a thorough test of this, but I have no doubt, from what was done, that it is as ineffective against the mites as bisulphid of carbon. One large bed in a cellar by itself was left from Saturday 4 o'clock to Sunday 4 o'clock, exposed to the fumes of hydrocyanic acid, produced in the usual way. When the windows were pulled open on Sunday strong fumes were still found.

No living mites were noticed at the inspection on top of the bed, but digging into the bed the following day revealed them apparently as well as ever. Concerning the influence of these vapors on the growing mycelium this experiment gave no information, as the mycelium in this bed was already dead when exposed to the gas.

(F) *Tobacco dust* was tried in a single bed, and gave the same negative result as sulphur, acting at most only as somewhat deterring but not killing the mites.

(G) *Chloride of lime and gasoline*.—Neither was given sufficient trial to warrant final conclusions. The former killed the mites which came in contact with it, but two beds on which it was applied did not produce any mushrooms either. The gasoline did not seem to have any fatal results either to mites or mushrooms.

(H) *Moisture*.—A mushroom bed does not allow much variation in moisture if good results are to come. However, it was soon observed

that the mites easily got too much moisture, and in this direction observations should be continued to find out whether it be possible to find a degree of moisture which will either kill or drive away the mites without being detrimental to the growth of the mycelium.

NOTES ON COLORADO INSECTS.

By A. N. CAUDELL.

Acting under authorization from the Department of Agriculture, I arrived at Denver, Colo., May 5, 1901, where I was joined by Dr. H. G. Dyar. With Denver as headquarters, daily excursions were made into the canyons and foothills of the mountains, and the life histories of many western Lepidoptera were worked out, notes being taken on more than 200 species. In the months of July and August trips were made across the divide to various localities, adding materially to our collections. According to instructions, I "collected such economic and other insects as came convenient and made observations on economic species whenever possible." My first duty of assisting Dr. Dyar in working out Lepidopterous life histories prohibited my making large collections in other orders. Some 5,000 specimens of Orthoptera, however, were collected, together with some hundreds of miscellaneous insects, mostly Coleoptera, of which a few were reared. Such observations on economic insects as I was able to make are here reported.

The minute false chinch bug (Nysius minutus Uhl.).—At Delta occurred an extreme case of injury to radish by this insect. The leaves were completely killed to the ground, and the shriveled remains were still covered by many hundreds of the little pests. Mr. O. Heidemann identified the species.

The beet army worm (Laphygma exigua Hbn.).—This has become an important enemy of the sugar-beet industry in the West. Specimens of the larva in all stages were taken on sugar beets at Palisades in Mesa County, and at Delta. At the latter place they were taken also on the table beet, though they did not occur in injurious numbers. This insect is reported as having caused great injury to sugar beets in Colorado, defoliating thousands of acres of beets. It is also said to be injurious to potato, pea, and apple leaves. Professor Gillette, of the Colorado experiment station, has employed arsenical sprays against it with beneficial results. Professor Forbes concludes from data furnished by Professor Gillette that there may be expected at least two broods of larvæ each year—one in June and one in August. But the broods doubtless merge one into the other, as larvæ in all stages were taken at Palisades on July 8.

The bean ladybird (Epilachna corrupta Muls.).—An extreme case

of injury by this spotted bean beetle was observed near Fort Collins, where a large patch of beans had nearly every leaf killed by the larvæ of this insect. At that time, in July, the beetles were in the pupal state, hanging in great numbers on the underside of the leaves. Professor Gillette stated that no effective remedy for them was known, the insect being able to withstand anything that did not injure the plants. The adult beetles are said to exude a tiny drop of yellow liquid of a pungent odor from each knee joint when disturbed. The insect is discussed by Professor Gillette in Bulletin 19 of the Colorado Experiment Station.

The apple flea-beetle (Haltica bimarginata Ill.).—July 19 a collecting trip was made up Platte Canyon. At Pine Grove, some miles up the canyon, the alders along the river were found to be infested by beetle larvæ which ate the upper side of the leaves, in some cases completely skeletonizing them. An attempt was made to rear the adult beetle, but other duties interfered and it was not successful. A number of the larvæ were collected, however, and Mr. Schwarz identifies them as those of *Haltica bimarginata*.

The tent caterpillar (Clisiocampa fragilis Stretch).—On July 20 the ascent of Pike's Peak was made, and here occurred the worst case of forest depredation by insect foes that ever came under my observation. The aspens were completely defoliated by the larvæ of *Clisiocampa fragilis*. The imagos were then issuing, and, even in the middle of the day, they swarmed about the tops of the leafless trees like bees, thousands and thousands of them. The cocoons literally covered the twigs, one a foot in length often containing a dozen or more of them. So completely defoliated were the trees at this place that Mr. Dyar failed to find a single leaf with which to supply an aspen-feeding Notodont larva which he was rearing. Our observations were made mostly at 9,000 to 12,000 feet altitude. The willow and rose were also attacked, but not nearly so severely as the aspen. Over what area this injury extended I can not say, being unable to make sufficient observations. In the vicinity of Cripple Creek the aspens were also infested, but not nearly so badly as those on Pikes Peak. On reaching the summit of the peak we found hundreds of the moths lying dead or helpless on the snow banks. They had evidently flown up from the timber line, and, becoming benumbed, fallen in the snow, there to die.

The lilac borer (Podosesia syringæ Harr.).—In West Denver numbers of ash trees were completely killed by this Sesiid borer. The trees were small, about 6 inches in diameter, and dozens of empty pupal shells were protruding through the bark.

The fruit-tree leaf-roller (Cacecia argyrospila Walk.).—The leaves of living ash trees were badly infested with the larvæ of this Tortricid.

A new tent caterpillar (Clisiocampa tigris Dyar).—The scrub oak in the eastern foothills, especially just west of Sedalia, between Denver and Colorado Springs, was badly infested with the larvæ of this new

species of *Clisiocampa*. Many of the trees (or more properly bushes, as they seldom, if ever, attain sufficient size to be properly called trees) were killed through repeated defoliation by the larvæ of this insect. A resident farmer stated that the caterpillars were much more numerous some years than others. This beautifully marked larva was first found some 5 miles up Platte Canyon, back of Denver, but occurred there very sparingly. It eats only oak and confines its attacks to young, tender leaves. It seems unable to eat old leaves, and so must mature before they become tough.

The eggs are laid near the ground on twigs at the base of the trees, and have no frothy covering as have many species of the genus. The larvæ are gregarious when young, but soon scatter and feed singly. They spin no web.

Trypeta galls on Bigelovia.—At the little station of Platte Canyon, at the mouth of the canyon of that name, there are great numbers of *Bigelovia*. During the latter part of May every bush bears a number of white fluffy but compact galls as big as hazelnuts. Often there will be found 50 or more galls on a single bush. They are caused by a beautiful little fly, *Acitura bigloria* Ckll. At this time of the year the pupæ may be found within the galls, snugly incased in cells at the center. The pupa is about 5^{mm} long by 3^{mm} wide, oval in shape, and varying in color from pale yellowish red to brown, probably according to age. The insects emerge by the first of June, the first ones appearing in the breeding cage on May 28.

The cabbage looper (Plusia brassicæ Riley).—In the early part of July a few observations were made on injurious insects of the garden in the vicinity of Delta, in Delta County. Several interesting items were noted. The larva of *Plusia brassicæ* was the main pest, and seemed to be quite omnivorous, eating not only the cabbage, but also the potato, turnip, rutabaga, lettuce, and table and sugar beets; it was also found on a prickly poppy-like plant locally called "wild lettuce." While the cabbage in some cases was almost ruined, it was on the lettuce and potato, especially the lettuce, that the most damage was done. Quite large fields of potatoes were so eaten by this larva as to be easily noticeable at a considerable distance, having something the appearance of being badly infested with the potato beetles. On the lettuce the damage was extreme. In some cases the plant was entirely devoured and was eaten out below the surface of the ground. The rutabagas and peas were also badly eaten. The larvæ occurred in various stages, some very small and others full grown. Specimens were sent to Dr. Dyar at Denver to be reared, but they failed to transform. An inflated larva was preserved.

The cottonwood leaf-beetle (Lina scripta Fab.).—The willows in the eastern foothills visited by Dr. Dyar and myself were badly infested with a Chrysomelid larva which often occurred in sufficient numbers to completely skeletonize the leaves of large branches. The beetles were

reared, and were determined by Mr. Schwarz. The eggs are deposited on the leaves about the middle of May, and are continually deposited for two or three weeks thereafter, all stages—ovum, larva, pupa, and imago—being found on the trees in the earlier part of June. They remain in the pupa state about five days, specimens in the breeding cage pupating on June 1, and giving forth imagos on the 6th. The larval period lasts but a couple of weeks, and breeding experiments would probably show the insect to be at least double-brooded.

The boll worm, or corn ear-worm (Heliothis armiger Hbn.).—Young corn a couple of feet in height near Delta was badly infested with the bollworm. The leaves were in some cases completely riddled near the base, and the stalks badly burrowed and eaten. This exceptional injury was probably accounted for by the nearness of the worst infested patch (a small area) to an irrigating ditch of considerable size. Corn in dryer locations seemed little injured. Corn on low wet soil is usually much more liable to excessive injury from the corn worm than on high dry ground. Some years ago in Oklahoma I saw a small area of field corn planted in a very low wet spot in the bend of a small creek that was completely eaten up by the worms. The stalks attained a height of only about 4 feet and were very weak and slender, yet 20 or more larvæ could be found in a single plant, burrowing the stalks so that many fell over. Some plants had all the leaves riddled and the stalk so completely eaten out that but part of the outer shell remained. So numerous were the larvæ that many of them were in a fully exposed position, feeding upon the leaves.

Grasshoppers.—Grasshoppers were very abundant in Colorado this year. Several reasons may be assigned for their unusual numbers. The season was favorable for their development, and the increasing abundance all over the State of the Russian thistle, which is a food plant of a large number of species, may have had considerable influence on the matter. Professor Bruner suggested also that the rapid killing off of pheasants may be a cause of grasshopper increase.

The prairie along the eastern foothills was swarming with various kinds of Acridiinae. *Melanoplus bivittatus* was probably the most common species. At Delta this locust threatened to do some damage, and it occurred sparingly at Grand Junction, while at Palisades, 12 miles north, none at all were seen. This is a very injurious species, and Professor Gillette places it on an equal footing with the codling moth as an injurious insect.

The saltbushes, *Sarcobates vermicularis*, about Palisades were infested with *Eolophus chenopodii* Brun. in large numbers. A small patch in the center of the little town was swarming with them. They were quite active, diving headlong into the prickly bunches of weeds, and proved quite difficult to capture. They were not at all common at Grand Junction, and were not taken on the saltbush there.

GRASSHOPPER NOTES FOR 1901.

By LAWRENCE BRUNER, *Temporary Field Agent.*

Owing to numerous reports received at Washington from many localities in the central West concerning the continued presence in more than normal numbers of several species of native grasshoppers or locusts, the subject was deemed worthy of investigation. Reports coming from portions of western Nebraska, eastern Colorado, and eastern and central Wyoming seemed so serious in their nature that the writer was commissioned by the United States Department of Agriculture to make an investigation, so as to ascertain, if possible, the true causes leading up to this undue increase among the several species of locusts concerned, and to report the results to the Entomologist.

Accordingly, August 8, in company with Mr. M. A. Carriker, jr., an assistant, who was to make some special observations and collections of specimens for the Nebraska Agricultural Experiment Station, a start on this tour of inspection was made. The route chosen was first to southwestern Nebraska via the Denver branch of the Burlington and Missouri River Railroad, and the first stop was at McCook. From this place the party proceeded by short journeys to Haigler, then to Akron, and to Brush. At the latter place turning to the north, and passing through Sterling, Colo., Sidney, Nebr., Bridgeport, and Scotts Bluff, they reached westward as far as Guernsey, Wyo., before returning to Alliance, Nebr., and Lincoln, by way of the Billings branch of the same railroad. On this return journey the central sand hill region was crossed and some notes on locust abundance were there secured.

Leaving Lincoln again on August 18, a second journey was made; this time via the Fremont, Elkhorn and Missouri Valley Railroad up the Elkhorn Valley, the Niobrara, the White River, and the North Platte, to Lusk, Douglas, and Casper, Wyo., where investigations were made concerning the locust problem as it existed in those regions; then returning as far as Crawford, in which vicinity some work was done, and finally going on to Denver, Colo., where the annual meeting of the economic entomologists was attended. From here the return trip to Lincoln was made over the Union Pacific Railway down the Platte River Valley. Thus most of the remaining territory occupied by the locust pest under consideration was covered. In these investigations the writer was greatly aided by having transportation furnished him by the railroad companies mentioned.

Other sections of the country were also visited and carefully studied, both before and since the period embraced by the commission mentioned, and the results of such investigations have been included in the conclusions arrived at and hereto appended.

The following notes pertaining to the subject under investigation were jotted down as the work progressed, and in part form the basis for the conclusions reached:

At McCook, Nebr., August 9, we collected some thirty-odds pieces of the native grasshoppers, which abound in this vicinity. Most of these were from common to numerous as regards abundance. In fields, both on the table-lands and in the valley, the *Melanoplus differentialis* was exceedingly abundant; in fact it appeared to be the principal species that was causing the injury to crops and cultivated plants. It was aided, however, in this work by such other forms as *M. bivittatus*, *M. atlantis*, *M. packardii*—of the form usually referred to as *M. fedus*—and *M. femur-rubrum*. Among the other species which existed in unusually large numbers were *Dissosteira longipennis*, *Æoloplus turnbullii*, *M. occidentalis*, *M. conspersus*, *M. lakinus*, *Amphitornus bicolor*, *Aulocara elliotti*, *Mestobregma kiowa*, etc.; but these latter were feeding mainly upon grasses, weeds, and special food plants other than cultivated ones.

In trying to ascertain just where the insects which were concerned in the devastation of crops had hatched, it was found that old breakings seemed to furnish many, while the forsaken roads, edges of fields and irrigating ditches, railroad beds, and like places, grown up to weeds, had provided still others with the required breeding places. Alfalfa fields growing next to corn nearly invariably occasioned much injury to the corn. Some of the fields of corn observed between McCook and Culbertson had been entirely destroyed, and in some instances even the weeds between the rows and about the edges were badly eaten. A few fields showed only here and there the remnants of bare stubs, just as I had seen fields appear in the early seventies after a visit from the Rocky Mountain locust plague.

In observing what plants, if any, were free from the ravages of the various locusts mentioned above, it was noticed that sorghum in most cases had suffered but little, while Kaffir corn was nearly exempt. Only when Kaffir corn was wilted did the locusts seem to touch it at all, and then but slightly if other food was available. Millet, too, seemed to be fairly immune against their attacks. Of course most kinds of garden truck suffered severely.

One feature noted in connection with the abundance of the supposedly harmless locusts was the presence in large numbers of *M. lakinus* and *Æoloplus turnbullii* on the Russian thistle and lamb's-quarters. Nearly everywhere that these weeds grew the grasshoppers just mentioned abounded. Only a few years ago both of these species of locusts were rare, usually extremely rare, and at the same time very local in their distribution. Since they have already been observed to attack the beet, they may both prove troublesome in the future should attempts be made at sugar-beet growing in the regions now overrun.

On the prairies and other uncultivated grounds two or three grasshoppers besides those mentioned above seemed to be abnormally abundant. *Mermiria bivittata*, *Opeia obscura*, and *Amphitornus bicolor* or

coloradensis being the chief ones. These, with the exception of the first, are found upon the higher grounds among the shorter grasses like the *Boutelouas*.

In driving and walking about over the country, in which movements 10 or 12 miles at a time were covered, few dead or sick locusts were seen, and inquiry among the farmers and other interested parties gave the same impression as to their comparative healthiness. No *Empusa*-killed 'hoppers had been seen by anyone during the present year, so far as could be learned, and only a few had been observed to die from "grubs" and from what is apparently either a bacterial disease or such a disease in conjunction with a *Sporotrichum*. At least this last surmise seems to be warranted, since the conditions of death coincide with observations made a week prior in an alfalfa field on the North Platte, about 17 miles to the northwest of the little town of Ogallala, where the locusts of various species had succumbed in large numbers. When these were placed in a dish for the purpose of ascertaining the cause of their demise there was obtained a fungous growth, pronounced by Dr. C. E. Bessey, of the University of Nebraska, to be a species of *Sporotrichum*. Several bacteria were also present in large numbers within the bodies of some of the above-mentioned dead locusts.

Inquiries made among the railroad employees at McCook showed that these insects reached eastward as far as Red Cloud in numbers sufficiently great to perceptibly injure cultivated vegetation in both gardens and fields.

In passing westward from McCook along the line of the Burlington and Missouri River Railroad, locust injury was observed all the way to Haigler, but seemed to be the most pronounced between the former place and Stratton.

From different persons questioned concerning the various measures that had been taken to combat the locusts in this portion of the State, it was learned that the kerosene pan had been used in a few cases, while disking had been resorted to by some, and several had even attempted the use of poison in the form of Paris green mixed with bran. In some instances also large flocks of chickens and turkeys produced some good results. Altogether, however, but little had been accomplished, and no concerted action had been undertaken by the settlers to rid themselves of the pest. It would require a concerted action over the entire area affected, for at least two or three years in succession, to obtain complete control of the pest.

Whether or not the killing off of the native birds in this section of the State has been much of a factor in permitting this abundance of the locust is a query. One farmer near McCook remarked that a couple of years ago a certain locality near one end of a particular field of his had been protected by blackbirds, a hundred or more pairs

of which built nests and reared their young near by. Recently, however, the small willows among which these birds nested had been removed, and the birds no longer protected that particular field.

At Haigler it was ascertained that various species of locusts have been more than normally abundant for the past six years. At least this can be said of the species which attack cultivated plants like alfalfa, corn, wheat, garden truck, etc. If any change in their numbers has occurred it is thought that perhaps there is a slight decrease from last year. As in the vicinity of McCook and farther east, they seem to breed chiefly in alfalfa fields, along roadsides, and in old breakings. In addition to the breeding places here recorded, the Russian thistles, which have become generally dispersed over this section of the State, seem also to offer safe and desirable retreats for several species of these insects when laying their eggs. Not only is this true at egg-laying, but also at other times. These rank-growing plants provide shelter during hot, dry weather, as well as from rain and hail storms, and offer safe retreats to the insects, even when pursued by such enemies as predaceous insects and birds.

Of the enemies to wild plants among these insects those which appear to be most beyond the normal in numbers in this vicinity seem to be *Opeia obscura*, *Mestobregma kiora*, *Melanoplus lakinus*, *M. bowditchi*, *M. packardi*, *Mermiria birittata*, *M. neomexicana*, and one or two others. As noted at McCook, several of these latter are partial to certain food plants which have recently increased enormously, which fact probably explains their excessive numbers. On the other hand, species like the Mermirias and other grass-infesting forms now abnormally abundant have become so from some other cause. Perhaps the nonoccurrence of prairie fires for a number of years may account for this, at least in part, while the destruction of such birds as the sharp-tailed grouse and Bartramian sandpiper, with the meadow lark, and a few other kinds of prairie-inhabiting species, will explain the excess in numbers of some of the remaining grasshoppers. Three species of *Decticinae* were also quite abundant here, as was also one of the walking sticks.

In journeying westward from Haigler grasshopper injuries were detected nearly as far as Akron, Colo., but beyond this point only about the normal numbers of these insects appeared to be present, since none of their injury was visible from the train. At Brush, where a great deal of alfalfa is grown, not many of these insects were reported or seen. Hence it was judged that matters here were nearly normal as regards locust abundance. From this point the direction of the journey was changed and we went north. At Sterling, which was passed before daylight and where considerable injury was reported a year ago, the condition was not ascertained, but judging from what was seen some distance beyond along the line of railroad toward Sid-

ney the locusts may be on the decrease—a result, perhaps, of some concerted efforts on the part of the farmers toward their destruction during the past two or three years.

It was also found upon investigation that these insects were not nearly so numerous at Sidney as they were farther to the east along the Lodgepole Creek and the South Platte River. Still, even at Sidney, wherever and whenever cultivated fields occurred, more of these insects were to be met with than is normally the case in the region. They were of the usual species observed under similar conditions the present year, viz., various species of the *Melanopli*, as *differentialis*, *bivittatus*, *femor-rubrum*, and *atlantis*. Some of the other forms that were not so rare as at times in the past were species like *M. packardii*, *M. occidentalis*, *M. luridus*, *M. infantilis*, etc., while a few of the prairie-inhabiting species mentioned before were also quite plentiful.

In conversing with Mr. George Oberfelder, a merchant of Sidney and a ranchman, I learned that at Lodgepole the locusts were not nearly so plentiful on his ranch as elsewhere in the neighborhood. It developed from further conversation with him that on this particular ranch are located several quite extensive private fish ponds and low and swampy ground, where two or three species of blackbirds breed, and were, at the time referred to, gathered in immense flocks. The presence of these birds will undoubtedly explain this comparative freedom from locusts on the ranch in question. Mr. Oberfelder also mentioned the fact that a great destruction of the bird life, in general, of the region had been accomplished during recent years by local and other would-be sportsmen.

While at this place, in conversation with a gentleman from Gering, Scotts Bluff County, it was learned that during the present year there were more grasshoppers in the Pumpkinseed Valley, to the south of Gering and Mitchell, than there were last year, and also more during the present year (1901) than at Gering and Mitchell. This he accounted for on the ground of a partial migration southward both by the old insects prior to their egg laying last fall, and again since hatching during the past spring and early summer. Just what species of these insects were present in this last-named region was not ascertained, but it is presumed that most of them were of the kinds noted at nearly all other points where cultivated vegetation suffered from grasshopper depredations. It is also quite evident that several of the prairie-frequenting species like *M. packardii*, *M. occidentalis*, the *Aulocaras*, some of the species of *Trimerotropis*, *Trachyrhachis kiowa*, *Opeia obscura*, etc., were present in more than normal numbers, since a scarcity of food on the ranges is reported, notwithstanding the fact that more than the usual amount of rain had fallen during the past spring and summer.

In running west from Bridgeport to Guernsey, Wyo., it was observed

that locust depredations appeared to lessen materially as the train progressed westward after entering Wyoming. Still even here more of these insects were to be seen among the weeds along the railroad track than was the case during their normal abundance in past years. There were a number of kinds to be met with in the grasses about Guernsey, but the prevailing species seemed to be *M. packardii*, *M. occidentalis*, *M. atlantis*, *Aulocara elliotti*, *A. femoratus*, and still others, which, like the *M. differentialis* and *M. atlantis*, seem to hatch among rank-growing weeds as well as upon cultivated or disturbed grounds.

In trying to find a reason for the greater increase of locusts in certain localities during different years, the matter of rainfall seems to offer an explanation for at least a portion of this variation. It is quite noticeable that when rains fall early in the season the eggs of these insects hatch much earlier than they do when the rains come later, although the temperature may be normal or even above normal. Then, too, after each shower during late spring and throughout the summer, it is seen that additional young ones hatch. During some years it may even be possible for many of the eggs that were deposited the previous fall to remain unhatched for lack of the requisite amount of moisture. Should the following year prove to be a wet one these eggs might then hatch along with those deposited a year later. That the present year has been an exceptionally wet one in portions of the Northwest may, therefore, account for the immense numbers of grasshoppers that were to be found in that section. Still, there are limited localities even in this region where scarcely any of these insects were to be met with during the present summer, while immediately adjoining they were literally swarming. While returning eastward from Guernsey a severe rainstorm accompanied by hail was passed through. Fully an inch and a half or two inches of rather large hailstones fell over a strip of country several miles in width and many miles in length. During the progress of this storm the thought occurred to me that possibly here was an explanation of the comparative freedom of certain areas right in the midst of others that were greatly overrun by destructive locusts. The hail in this instance certainly fell with force and in quantity sufficient to crush out the life of the majority of locusts inhabiting the region in question. Then, too, these sections of comparative freedom from the pest so frequently observed by the writer are such as are subject to severe hailstorms.

As intimated on a previous page, the Russian thistle, in addition to affording an abundant food supply for certain species of the native locusts, provides excellent shelter for their eggs as well as the insects themselves. Tucked away beneath these formidable plants both the insects and their eggs are well protected from most of their natural enemies, as well as from sudden changes of weather. This being true, the Russian thistle no doubt must have had something to do with pro-

ducing the present conditions in portions of the region now covered by the locust plague.

At Caspar, Wyo., August 20, conditions while rather bad were not nearly so alarming as they were in some portions of Nebraska, and farther east in Wyoming. In driving out among the ranches and over the range some new light on the probable cause of the recent increase among grasshoppers in this and other regions of the country was secured.

Upon driving up to the buildings on a ranch on Goose Creek, about 10 or 12 miles southeast from Caspar, a very nice flock of sage grouse (30 or more) was observed walking about the premises and picking up grasshoppers. These grouse were so tame that they reminded one of domestic fowls as they worked about among the vegetation in search of grasshoppers. During the day several additional coveys of these grouse were seen and the remnants of several dead birds that had been shot and drawn by hunters offered opportunities for examining the stomach contents. Such examinations invariably resulted in the finding of large quantities of grasshopper fragments. By inquiring around among ranchmen it was also ascertained that a great slaughter of these birds had been going on for the past few years in the sections of Wyoming now most overrun by locusts. A careful survey of the field brought out the fact that a similar destruction of these birds, as well as of the sharp-tailed grouse, has been progressing over considerable country. It was learned that such slaughter had occurred at Chadron, Crawford, Harrison, McCook, Culbertson, Trenton, Haigler, North Platte, and Sidney, in Nebraska; and at Lusk, Douglas, Orin Junction, Guernsey, and elsewhere in Wyoming. At each of these localities the grasshoppers were more numerous during the past summer than formerly.

When this idea first came up in connection with other probable reasons for the increase of the various species of locusts found it did not seem at all probable, but the more I consider it, the more I am inclined to accept it as an important factor in the problem. When we take into consideration the fact that when man occupies a new area he finds the forces of nature nearly or quite in a state of equilibrium, no one form of life having much the advantage over others, then does this explanation of the matter appear quite possible. The country undisturbed by man affords food for a certain number of mammals, birds, reptiles, and insects, all of which are more or less interdependent. If, for instance, man removes a few hundreds of the individuals of any one species, he soon finds a change taking place in the numbers of individuals of some other form. The birds feed on both vegetation and insects. If grasshoppers are included in their food a smaller number of birds will require a less number of 'hoppers, and the latter will thus be given the opportunity to increase beyond the normal. This

surplus goes on increasing and very soon causes a greater drain on the vegetation that forms their bill of fare. Supposing that a single sage hen will destroy on an average 100 locusts each day during the months of June, July, and August, the removal of this bird from the field of action will mean at least 9,000 grasshoppers saved to swell the army of these insects that may go on eating and propagating. If half of these should be females, and each one should deposit its normal quota of 100 eggs, there would be a possible 150,000 more of these insects than if the bird had not been killed. But when we destroy the birds by the hundreds of thousands the possibilities become startling, and this solution to the problem seems more than probable.

Aside from the killing off of these birds by man, it is stated that they are destroyed to a considerable extent by grazing sheep which break up their nests. While conversing with an intelligent sheepman and herder on this feature of the subject, he mentioned the fact that he had heard of more than a hundred nests being thus destroyed in a single year on Hams Fork in western Wyoming. Whether or not the destruction of locusts by the trampling of sheep will equal the number that would have been killed by the birds thus destroyed, I am not prepared to state at this time.

The species of grasshoppers concerned in the depredations on cultivated tracts in the vicinity of Douglas and Casper, Wyo., were: *M. bivittatus*, *M. atlantis*, *M. femur-rubrum*, and *Camnula pellucida*; while the ones most abundant on the range were *Aulocara elliotti*, *A. femorata*, *Mestobregma pardalinum*, *Melanoplus packardii*, *M. infantilis*, *M. occidentalis*, and several others.

While occupied in other work in portions of Dawes and Sioux counties during June, July, and August, 1901, the writer gave considerable attention to the locust problem as it existed there. A couple of students who were engaged in making collections of various forms of the animal life of northwestern Nebraska were also instructed to pay particular attention to these insects in the region being worked by them. The forms that frequent both cultivated and uncultivated grounds were found to be unusually abundant over much of the country traversed. Still some sections were much more overrun by them than others. Especially was this found to be the case in portions of Dawes and Sioux counties, Nebr. In the latter county in particular the insects were most plentiful on the slopes adjoining the Pine Ridge and for a few miles away; but not so on the table-lands nor in the Hat Creek Valley itself. In many places the insects were so numerous as to cause a shortage in the feed on the range notwithstanding the great amount of rain that fell here during the early part of the year. As noted in other localities, some species of insects normally rare in this section of the State were found to be present in large numbers.

Not only were the "native" locusts abundant throughout the western

counties of Nebraska, but in many localities even in the central and eastern portions of the State, where they did much local injury to garden truck and some field crops. Some of the localities where such a state of affairs existed were in Antelope, Knox, Dixon, Cedar, Holt, Valley, Custer, Lancaster, and counties adjoining these. In these sections the differential, two-lined, red-legged, and lesser migratory species predominated, though others were also present in fair numbers both upon the prairies and in cultivated fields. A number of the local districts thus overrun were visited by myself or some member of the entomological department of the University of Nebraska, while others could not be reached for investigation. It was found that some of these outbreaks embraced only a few farms or several hundred acres of territory, while others extended throughout entire counties. The species of locusts concerned in these also varied with the districts and the nature of surroundings and crops grown. It was noted, however, that *Melanoplus differentialis* and *M. bivitatus* were usually the chief offenders.

One of the most important of these local or detached areas of locust abundance was that in Custer County, with Broken Bow as a center. In this region the plague assumed really alarming proportions, and caused not a little uneasiness among the citizens, who earnestly sought aid from the State entomologist and all other persons who might be in a position to give expert advice.

After carefully going over all the notes which have been brought together during the various trips made while investigating this and other insect pests and those accumulated in other ways, it is found that the area now occupied by these insects in injurious numbers has become much larger during the present summer (1901) than it was a year ago. Practically all of the State west of the one hundredth meridian is embraced, while the valleys of the Niobrara, Elkhorn, North and South Loup, Platte, and Republican rivers are all more or less largely overrun for 50 to 100 or more miles eastward. In some instances this is true locally, even to the extreme eastern edge of the State.

In order to show clearly the principal species of locusts thus concerned, and their distribution over the country, the following list has been prepared:

Mermiria bivitata Serv.—McCook, Haigler, Sioux County, and in the sand hills generally on unburnt prairies.

Mermiria neomexicana Thom.—Haigler and other southwestern Nebraska localities, where it is found in company with the preceding species.

Amphitornus bicolor Thom.—A plains locust which occurs from middle Nebraska westward to the Rocky Mountains, where it is to be met with in great numbers, especially on the higher grounds among the shorter grasses.

Opeta obscura Thom.—McCook, Culbertson, Haigler, Sidney, Scotts Bluff, Crawford, and Harrison, Nebr.; Akron, Sterling, and Brush, Colo.; and Guernsey, Douglas, and Casper, Wyo.; most abundant in buffalo grass.

Alpha occipitalis Thom.—Western Nebraska and eastern portions of Colorado and Wyoming; partial to gravelly and sandy soils.

Alpha crenulata Bruner.—Southwestern Nebraska, western Kansas, and the plains of Colorado, in company with the preceding.

Philobostroma quadrimaculatum Thom.—In the same general region as the two preceding.

Ageneotettix scudderii Bruner.—This locust occurs throughout the plains region, but is most abundant among the short grasses on high grounds.

Boöpedon nubilum Say.—Observed in abnormal numbers at Haigler and Stratton, Nebr., and Wray, Colo.

Aulocara elliotti Thom.—McCook, Culbertson, Haigler, Sidney, Scotts Bluff, Sioux County, Nebr., and Guernsey, Lusk, Douglas, and Casper, Wyo. It was also present in abnormal numbers in portions of western Kansas and eastern Colorado. It is a grass-infesting insect.

Aulocara femoratum Scudd.—With the preceding species, but most abundant southward.

Camnula pellucida Scudd.—This locust was seen only in the extreme western part of Nebraska and at Casper, Wyo., where it occurred on low land about streams and in mountain meadows.

Dissosteira longipennis Thom.—A native of the high prairies of western Kansas and Nebraska and eastern Colorado and Wyoming; not nearly so abundant as it was four or five years ago.

Mestobregma kiowa Thom.—A grass-infesting locust that occurs everywhere between the Missouri River and Rocky Mountains, but chiefly on high ground.

Mestobregma pardalinum Sauss.—A grass insect found chiefly in western Nebraska, northeastern Colorado, and eastern and central Wyoming.

Schistocerca alutacea Harr.—This insect was reported to be present in large numbers at Neligh, Albion, Haigler, Ogallala, and throughout the sand hills of central Nebraska generally.

Hesperotettix pratensis Scudd.—Antelope, Holt, and Wheeler counties on the prairies, but usually on low ground, where certain species of golden-rod abound.

Hesperotettix viridis Thom.—Eastern Colorado and Wyoming and western Nebraska, where it is restricted to certain localities.

Hesperotettix speciosus Scudd.—Western Kansas and Nebraska and eastern Colorado, among different species of sunflowers.

Eoloplus turnbullii Thom.—In the same general region as the preceding, where it seems to be partial to chenopodiaceous plants.

Eoloplus regalis Dodge.—Northwest Kansas, southwest Nebraska, and eastern Colorado, on rather high grounds.

Melanoplus borditchi Scudd.—Western Kansas and Nebraska and eastern Colorado and Wyoming on *Artemisia longifolia*.

Melanoplus flavidus Scudd.—This insect was noticed in numbers at Culbertson, Sidney, Scotts Bluff, North Platte, Ogallala, and Neligh, Nebr., and at Guernsey, Wyo. It appears to be partial to low, sandy soil.

Melanoplus packardii Scudd.—McCook, Culbertson, Haigler, Ogallala, Sidney, North Platte, Crawford, and Harrison, Nebr., Wray and Sterling, Colo., and Guernsey, Douglas, and Caspar, Wyo. The rufous form usually mentioned as *M. foedus* is by far the most numerous.

Melanoplus coccineipes Scudd.—Fairly abundant at Culbertson, Sidney, Ogallala, North Platte, and Fort Robinson, in Nebraska, where they seemed to choose the *Cleome serrulata* as a food plant, or at least upon which to perch.

Melanoplus infimilis Scudd.—On the high prairies in western Nebraska and eastern Wyoming.

Melanoplus femur-rubrum De G.—Throughout the region in cultivated districts.

Melanoplus plumbeus Dodge.—At Haigler, Nebr., on weeds and other rank vegetation.

Melanoplus lakinus Scudd.—Western Kansas and Nebraska and eastern Colorado, on Russian thistle and lamb's-quarters.

Melanoplus occidentalis Thom.—On the open prairie, west of the one hundredth meridian, in all four States in which work was done during the summer.

Melanoplus atlantis Riley.—Cultivated grounds generally, but less numerous than *M. femur-rubrum*.

Melanoplus bivittatus Say.—In nearly every locality where locust depredations were reported, and especially in cultivated districts.

Melanoplus differentialis Uhler.—Possibly the most abundant of all the species of locusts mentioned in this paper, and present in all localities except those in the extreme northwestern corner of Nebraska and central Wyoming. The chief insect in alfalfa districts.

Of these the following species seem to be confined more or less closely to special food plants, and are therefore somewhat restricted in their distribution:

Hesperotettix pratensis Scudd.—On *Solidago graminifolia* or *S. caroliniana*.

Hesperotettix viridis Thom.—On *Haplopappus spinulosus*.

Hesperotettix speciosus Scudd.—On *Helianthus*, several species.

Eoloplus turnbulli Thom.—On Russian thistle and lamb's-quarters.

Melanoplus bowditchi Scudd.—On *Artemisia longifolia*.

Melanoplus lakinus Scudd.—On Russian thistle and lamb's-quarters.

Those which are especially noticeable as enemies of cultivated crops are *Melanoplus differentialis*, *M. bivittatus*, *M. femur-rubrum* and *M. atlantis*, along with *M. packardii*. The remainder are chiefly grass eaters or feed upon various uncultivated plants.

WHY LOCUSTS INCREASE ABNORMALLY.

After having carefully scrutinized the notes relating to the locust problem in the region embraced in the investigations chronicled on the preceding pages, together with all other available information on the subject in general, the writer has come to the following conclusions as to why grasshoppers increase abnormally:

- (1) The growing of alfalfa without regularly disking the ground each spring.
- (2) The abandoning of once cultivated fields, and permitting thereon the growth of weeds and other rank herbage.
- (3) The very general carelessness of allowing weeds and other rank growths to flourish along roadsides, irrigating ditches, and railway tracks.
- (4) The presence in great abundance of the Russian thistle in portions of the country year after year.
- (5) The non-burning of prairies over wide areas for a number of years in succession.
- (6) The undue destruction of game and other insectivorous birds over wide areas.
- (7) The recurrence of unusually wet years after several abnormally dry ones.
- (8) The absence of insect enemies and diseases brought about by various causes, chiefly climatic.

It is but just to state here that lack of space prevents a very elaborate discussion of these various reasons for locust increase.

KILLING DESTRUCTIVE LOCUSTS WITH FUNGOUS DISEASES.

By LAWRENCE BRUNER, *Temporary Field Agent.*

The fact that various kinds of insects are at times attacked and destroyed by different species belonging to several distinct genera of fungi has been known to both botanists and entomologists for many years. It is, however, a matter of comparatively recent discovery that some of these fungi can be artificially grown and afterwards communicated to the insects which it is desired to destroy. Numerous examples of the propagation and spread of such fungi have been recorded in this and other countries. Some noted examples of this kind are the artificial spread of *Isaria densa* Link, the fungus that attacks the European cockchafer and that has also been tried on the white grubs here in the United States; *Sporotrichum globuliferum* Spag. as used against the chinch bug and several other insects, and *Empusa muscæ*, the common fungus of the house fly. Along with what has been recorded concerning these attempts at utilizing the fungi just mentioned, it might be well here to outline some of the efforts that have been made during recent years toward fighting destructive locusts or grasshoppers by similar means. It is not necessary, however, for one to devote much time in investigation to ascertain that the whole matter relating to this subject is still in great confusion. It will at once be apparent that nothing very definite exists in the shape of reliable information concerning the particular fungi that may be present and available in each of the regions where there is need for waging war against the locust plague. Even the botanists who are interested in this group of plants seem to have done comparatively little toward isolating and separating the species, from the standpoint of the systematist.

During the early seventies, when such vast swarms of the Rocky Mountain or migratory locust were devastating the country between the Mississippi River and the Rocky Mountains, attention was frequently called to an apparent disease which occasionally made its appearance among the devouring hordes of that pest in various sections of the country. After a little investigation on the part of members of the Entomological Commission and others, this fatality among the locusts was found to be due to the presence of a fungus which is now generally recognized as *Empusa grylli*, although it has been several times described under other names.

While locusts in general are more or less frequently attacked by these fungi, particular ones among the locusts indigenous to each country seem to be more subject than others. These usually, though not always, happen to be the forms that at times become so greatly multiplied as to be pests. This fact would indicate that it is necessary for the insects to come in contact one with another in order to spread the fungus sufficiently to develop an epidemic.

These epidemics of the disease usually occur during warm, wet weather, or after such conditions of climate have been prevailing for several weeks in succession. They are also quite apt to develop among the insects living along the edges of irrigating ditches or on grounds which have been thoroughly watered, rather than on those which are comparatively high, dry, and more or less widely removed from water or rank, succulent vegetation.

Early in 1896 (March) the subject of utilizing locust-attacking fungi as a means of destroying these insects came more prominently before the public. In South Africa, where two species of these insects had been a pest for several years, it was found that a disease of a virulent nature had broken out and was prevalent in the form of an epidemic among the swarms in certain localities. An investigation instituted at the time showed this disease to be due to the presence of one of these species of fungi. Armed with the assurance that other insects had been successfully inoculated and destroyed by fungous diseases in Europe and the United States, members of the staff of the Bacteriological Institute in that country took the matter in hand and were successful in their attempts to isolate a fungus which was thought to be the one that was destroying the insects in question, a species of large migratory locust (*Acridium purpuriferum* Walk.). A brief account of the methods followed and results obtained from this work is given by Alexander Edington, the director, in his annual report for 1898 of the Colonial Bacteriological Institute, located at Grahamstown, Cape of Good Hope.

A year or so later (June, 1897), during investigations that were being made at the time in connection with the large migratory locust of the Argentine Republic (*Schistocerca paraguayensis* Burm.), the writer discovered what appeared to be still another and quite distinct species of these locust-destroying fungi—a *Sporotrichum*. This discovery was made at Carcaraña, a little town in southern Santa Fe, on the Central Argentine Railway, and some experiments conducted later during the same year demonstrated its usefulness, under certain limitations, as a means of combating that insect. The South African fungus referred to above was also tried on the same locust, but with exceedingly poor results so far as could be ascertained at the time. Still more recent attempts at destroying various kinds of our North American locusts with both of these fungous diseases (South African and Argentinian) have resulted in no marked degree of success, so far as the writer is concerned at least.

During the past two or three years other persons have been conducting similar experiments with these same, and apparently some other, locust-killing fungi. A few of these recent experiments carried on by other workers seem to have proven more successful than those just mentioned above. One in particular appeared to be very prom-

ising at the time it occurred. This was at Sterling, Colo., and was conducted by a Mr. George W. Martin, who obtained tubes of the fungus culture from the Department of Agriculture in Washington. The writer on visiting the locality found that, although the native locusts of two or three species were dying in large numbers, they all fell to the ground instead of clinging to the vegetation, as they should have done if death had resulted from the South African disease according to the account referred to above. Then, too, reports of similar fatalities among the 'hoppers, coming from localities widely removed from where the fungus in question had been distributed, seemed to indicate the presence of another and entirely distinct disease. During the present year (August, 1901,) a culture of a species of *Sporotrichum* has been secured from such dead insects gathered on the North Platte River and about 16 miles from Ogallala, Nebr.

In Australia it is reported that a fungus determined as *Mucor racemosus*, cultures of which were obtained from South Africa, has proved so useful in destroying the destructive locusts of Victoria that it is no longer considered an experiment, but has passed into a matter of everyday practice. Either this same *Mucor* or a closely allied one is also claimed to have been secured from insects which died as the result of an outbreak of a locust disease in Mississippi, as will be referred to more fully further on.

It will be seen from what has just been said that there are without doubt several distinct kinds of these locust-killing fungi, and that they are not the same the world over. The knowledge of this fact is perhaps very fortunate if we are to profit at all in our attempts to make use of them in dealing with the locust pest.

Since each species of locust differs in structure and habits more or less markedly from all others, and the climatic and other conditions by which they are surrounded in their respective habitats are so dissimilar in many instances, it must be true that a great diversity likewise exists among them as regards hardiness. Hence it is natural for us to suppose that the various fungi which are apt to attack and destroy them must also vary in these respects. That such a conclusion is warranted can be gathered from what follows.

EMPUSA GRYLLI.

Perhaps the most characteristic of these different locust-attacking fungi is the one recognized the world over as *Empusa grylli* Fres. It has been known, botanically at least, since 1856, when it was first described by G. Fresenius (*Botanische Zeitung*, Band XIV, p. 882, 1856). Not only does it attack the different species of destructive locusts (members of the family Acridiidae), some of the hairy caterpillars, and a few of the crane flies along with their larvæ, but it is also frequently to be found as an enemy of various other Orthopter-

ous insects. Among these latter it has been observed especially as an enemy of some of the representatives of the two remaining families of saltatorial Orthoptera—Locustidæ and Gryllidæ.

This malady is quite readily recognized, since the host when affected by it has a tendency before death to crawl upward upon the vegetation where it chances to be at the time of infection. Here it grasps the leaf, twig, or stem closely and fastens itself so securely that it remains clinging tenaciously even after death. As stated above, all kinds of locusts and also their relatives are affected alike by it; and many of their dead bodies may frequently be seen still attached to the vegetation in late fall and early winter. Just what the pathological effect is upon the victim, which causes this tenacious grasping or clutching with the front and middle legs, may never be known. Yet, in a general sense, it may be remarked that all insects dying from the effects of any of the allied species belonging to the genus *Empusa* exhibit this same characteristic of climbing before death. Even such characteristically subterranean insects as the various species of *Ceuthophilus*, or camel crickets, when attacked by this fungus, are known to leave their customary moist, dark haunts and climb up bushes and other vegetation even to the height of several feet, where their dead bodies may occasionally be seen hanging for some time afterwards.

Whether or not the *Empusæ* which attack the various orthopterous insects in different portions of the earth are identical in species is not definitely known, although they are supposed to be so by some of the leading mycologists who have studied these peculiar parasitic plants. Be this as it may, minor variations in growth and structure have been noted among the forms indigenous to the different countries where collected and studied. These differences have led to the multiplying of names, so that we now have at least three distinct names, if not that many actual species.

An insect, when once attacked by this fungus, soon shows signs of unrest and ceases feeding. It shortly becomes "dumpish" and in due time attaches itself to the vegetation as stated above. The whole body, but more especially the abdomen, swells greatly and seems to be literally filled with a mushy, granular substance which, upon drying, changes to a brownish, dust-like character. A little later this dust, which is made up largely of resting spores, escapes through the breaks between the joints of the insect's body and is scattered broadcast by the winds.

Comparatively little is known concerning the life cycle of this fungus or of the methods by which infection of the host occurs from year to year. That it must be done by contact rather than through the alimentary canal is quite probable, judging from reports of experiments made by Dr. Roland Thaxter and mentioned in his *Monograph of the Entomophthoræ of the United States*. The resting spores must also

be exceedingly tenacious of life, since several years may elapse between outbreaks of the disease. Still no such regular intervals of recurrence of the disease have been noted as would tend to show a periodicity. Neither does there seem to be a regular time of the year for its appearance, nor has it a preference for insects of any particular age, since those of all ages seem at one time or another to succumb to its attacks. Sometimes, though rarely, it may be noticed first in late spring or early summer; at others, and more frequently, during midsummer, and again even in late summer and early autumn, or possibly not until just before cold weather commences in late fall, when it seems to be most common.

Dr. Thaxter says: "The artificial propagation of *Empusa* by the infection of fresh hosts I have found a much more difficult matter than one would suppose, even where the infected host was of the same species as that from which the spores were obtained for this purpose." (L. c., p. 152.) Not alone has Dr. Thaxter found this difficulty in securing artificial infection, but other persons have also learned the same fact fully when attempting to make use of the fungus as a means of destroying locusts. In truth, the writer has found it impossible to impart the fungus artificially to a single insect in either the laboratory or the field. It might be well, however, to state here that these experiments by the writer were purposely carried on in a very crude manner, since their object was to secure results that might also be obtained by farmers who are not equipped with carefully arranged laboratories.

If we make an exception of the matter on this subject that has been reported from the Bacteriological Institute of Grahamstown, Cape of Good Hope, it appears that up to the present time all of the experiments that have been attempted for the purpose of growing this fungus artificially in the laboratory have been very unsatisfactory. After having studied the subject carefully by reference to the available literature, and noting critically such facts as appear pertinent, and which are given below, it is the writer's opinion that the exception just suggested is justifiable.

The typical region for *Empusa grylli* is Europe, and in that country perhaps it has been most frequently reported. But the reader should not infer from this statement that this fungus is of rare occurrence elsewhere, for such is not the case. Here in North America it is among the most abundant of fungus plants, and it is to be regularly met with each year in suitable localities throughout the length and breadth of the land. In fact, it very frequently occurs as an epidemic among the locusts in regions where various species of these insects have developed as pests. This same or a closely allied fungus was occasionally referred to by correspondents as indigenous to Argentina while the writer was in that country several years ago, and quite recently notices of its occurrence in Japan and the Philippine Islands have been seen.

By referring to the annual report of the Director of the Colonial Bacteriological Institute of the Cape of Good Hope for 1898 it will be learned that the much-advertised South African locust fungus has been determined by the working force of that institution to be an *Empusa*; and the name *Empusa acridii* has been suggested for it since it was reported to have attacked other species than the red locust (*Acridium purpuriferum* Walk.), one of the chief destructive species of that section. Plates I, II, and III, which are photographic reproductions accompanying that report, show these locusts as they appear upon the vegetation after death caused by the fungus. Judging from what is known concerning the actions of insects after having been attacked by different fungi, a person who is conversant with the subject would at once pronounce the malady portrayed here to be that resulting from the presence of an *Empusa*. To verify this conclusion in part we have the following records: Mr. Charles P. Lounsbury, government entomologist, in the *Agricultural Journal of the Cape of Good Hope*, February 2, 1899, says that the disease is apparently identical with *Empusa grylli*, and quotes as authority for this statement Dr. Schönland and Dr. Black, of the Bacteriological Institute of Natal. Also Dr. Munro, in his book on the Locust Plague (p. 182), quotes from a Mr. Evans as follows:

On the 4th of this month I wrote a letter stating that a fungus had been found in a locust causing its death, and it was afterwards determined by Mr. George Murray, F. L. S., head of the botanical department of the British Museum, as *Empusa grylli*.

While the insects in question have apparently died as a result of the presence of an *Empusa*, an entirely different fungus appears to have been isolated from the dead locusts and afterwards grown in quantity and sent out from the laboratory to be utilized in fighting the same pests. In this report, referred to above, we find a description and illustrations of a fungus which in no wise resembles or approaches *Empusa*. In fact, both the descriptions and figures suggest a *Mucor* instead, and possibly the world-wide distributed *Mucor racemosus* Fres., which does not belong to the insect-destroying fungi at all, but to the ordinary molds. Strangely enough the tubes of the so-called South African locust fungus received by the writer, both while in Argentina during 1898 and here in Nebraska two years later, contained fine growths of what was evidently the above-named *Mucor*.

In glancing over the files of the *Journal of the Department of Agriculture of Western Australia* for July, 1901, a statement was found to the effect that "The destruction of locusts by means of a parasitic fungus (*Mucor racemosus*) has now passed from the domain of experimentation into that of everyday practice. The method which has been tried in various places where swarms of locusts proved troublesome to vegetation, notably South Africa, has been for the past two or three years successfully applied in Victoria."

The Agricultural Gazette of New South Wales (vol. 10, 1899, p. 1213) contains "A brief report of locust fungus," by D. McAlpine, in which the writer says that a fungus which has been used against locusts at Cape of Good Hope with good success has also been introduced into New South Wales and identified by him as *Mucor racemosus*.

In looking up the bibliography of the fungus called *Mucor racemosus* it was found that two quite distinct plants have received this name. One of these was described by Bulliard in Hist. Champs., France, and is said by DeCandolle to belong to the genus *Botrytis* as now limited. The name of this fungus would then appear as *Botrytis racemosa* (Bull.) DC.; while the other, which has been the one under consideration, should be known as *Mucor racemosus* Fres. (Beiträge zur Mykologie). The *Botrytis* has been found upon putrid, oily, or greasy substances in France and Germany, while, on the other hand, the *Mucor* occurs quite generally over the world as a common mold that attacks decaying, starchy, and other substances.

Being so generally distributed, and withal so readily grown, there is no wonder that this last mentioned should have been the fungus isolated, as heretofore stated, instead of the *Empusa*, which is extremely difficult to grow upon various culture media, such as are used for the artificial propagation of bacteria.

It might be mentioned also that in our experiments here at the University of Nebraska we have experienced great difficulty in isolating any particular fungus, and especially with recognized insect-attacking genera like *Empusa*, *Botrytis*, *Sporotrichum*, and *Isaria*. Almost invariably these would be accompanied by saprophytic fungi, such as *Mucor*, *Fusarium*, *Alternaria*, *Macrosporium*, *Aspergillus*, etc., which would very quickly crowd the others out.

If the reader will take the trouble to refer to the instructions which accompany the various tubes of this South African locust fungus when they are distributed he will find the following directions given for securing an abundant supply of the material:

Collect a large number of grasshoppers which have died from the fungus. Dig a hole in the ground about 18 inches deep and 1 foot wide. Strew some grasshoppers over the bottom, then sprinkle some water over them. Repeat with grasshoppers and again sprinkle until the hole is full. Do not press the grasshoppers in the hole, but leave them lightly packed. Then cover with a piece of tin or board and keep the hole thus carefully covered for four or five days. If warm weather, four days will be sufficient, but if colder a longer time will be required. At the end of this time remove the grasshoppers and spread them out in the sun for an hour or two, or until thoroughly dry. Now grind them into a meal. Of this meal, which may be kept dry for a long time until wanted, take two tablespoonfuls and add it to a large tumblerful of water, into which some sugar has been placed. Leave this in a warm place for twelve to forty-eight hours, and then treat live grasshoppers by dipping, etc., just as one does when using the fungus when supplied in tubes.

If such a proceeding as that just described does not result in the growth of a variety of common molds, *Mucor racemosus* among them,

nothing will do so. Even had the insects which were collected and buried been killed by poison, boiling water, heat, or in some other violent manner, and treated in a similar way, the result would in all probability have been quite similar. But when these insects die from disease and drop to the ground in a variety of localities, and later are gathered together, there is no telling how many different kinds of saprophytic fungi may have come in contact with and adhered to them. Even *Empusa*-killed insects, attached to vegetation a considerable distance from the ground, would themselves become infested, and under favorable conditions support a great variety of these molds.

In our experiments with the fungus mentioned in this paper as *Mucor racemosus* we have found that such locusts as have been dipped or sprinkled with sugar-water cultures of it are killed; but when turned loose in the field there is no apparent spreading of the fungus to other 'hoppers. Neither did we have any success in destroying them when the inoculation was attempted by feeding the fungus to the insects along with bread crumbs, etc., that had been used for culture media. It is surmised that by thus dipping the insects into the liquid containing the fungus some of the mycelial threads and spores of the latter enter the stomata, as well as the sutures between the rings of the abdomen and thorax, and start to grow, and in a short time use up the fluids and vital tissues of the body sufficiently to cause death.

Since none of the other fungous diseases of locusts, aside from that caused by *Empusa grylli*, seem to have received much attention heretofore, it has been thought best to devote some space to their discussion here. Especially does this seem warranted because of the numerous references made to them in these pages.

SPOROTRICHUM sp.

The first of these other locust-attacking fungi that deserves mention was discovered by the writer in 1897 while investigating the destructive locust problem of Argentina, South America. In the month of June, when the insect then under investigation was hibernating, or, more correctly speaking, resting, and confined chiefly to the more northern districts of that country, it was thought best to occupy the time in gathering data of various sorts. It was on one of the field excursions which were regularly made at intervals, as this work was progressing, that dead fungus-covered nymphs of the destructive locust were discovered securely tucked away in dense bunches of a species of grass common to a large portion of the open country. These dead *saltomas* (as the nymphs of these insects are called in that country) had evidently been destroyed by the fungus in large numbers during the previous year. Still, so securely were they tucked away in these clumps of grass that fully eight months later they not only remained nearly perfect in form, but also retained their colors sufficiently to make their identity certain.

Having had some previous experience with an insect-destroying fungus of a similar appearance in the destruction of quite a different insect in the United States, a preliminary examination of these fungous-covered locusts at once suggested a *Sporotrichum*. But in order to obtain a verification of this surmise, or to learn definitely the nature of the find, specimens of the dead fungus-covered insects were submitted to Prof. C. E. Bessey, of the University of Nebraska, who reported that the identification was correct. Although the genus to which this South American locust-killing fungus belongs has been definitely settled, various unavoidable circumstances have thus far prevented its specific identification.

Locusts that have been attacked by this South American fungus, instead of climbing to the top of various plants so as to get as much air and light as possible, creep away from the light and seek dark, moist places in which to die. Consequently they are most often found hidden away near the roots of bunch grasses, in the midst of dense, juicy foliage. Here, after death, their bodies become entirely filled with mycelial threads and spores of the fungus. In many cases, under certain conditions, the fungus growth also appears upon the outside and almost completely covers the dead body of the insect.

Some breeding-cage experiments attempted later in the year indicated that the fungus could be quite readily transmitted from these dead fungus-covered saltonas to live, healthy locusts of the same species. While out in the open "camp," the invading swarms soon began dying in rather large numbers in the vicinity where the fungus had first been discovered. On gathering the dead bodies of these latter and pulverizing them, and afterwards strewing this powder upon others along with their food, the result was that they too were found to sicken and die.

The action of this fungus upon the host is similar to that of *Sporotrichum globuliferum* on the chinch bug. At first the victim becomes restless, ceases feeding, and begins to wander aimlessly about, and, shortly before death, it seeks a secluded spot in some dark nook upon or near the ground. Quite frequently, after a passing flight of an infected swarm, the ground was found to be strewn with the dead bodies of such insects as had succumbed to the disease. These soon turned bright pink in color, and where they failed to reach a sufficiently moist and shady place shortly became quite hard and leathery in texture instead of rotting and breaking into fragments, as is customary with dead insects of this class. Also at the "roosting places" of such swarms many of these pinkish-colored locusts were found upon the ground, having succumbed and dropped during the night. Some of these latter, although winged, have been known later to exhibit the characteristics of those shown in the illustration already referred to.

During the period in which this fungus was epidemic among the

locusts in the southern portion of Santa Fe, and while under the observation of the writer, only four distinct species of locusts were found that had died as the result of its attack. These were the large migratory species of Argentina and the neighboring countries, *Schistocerca paratensis* Burm., *Zoniopoda tarsata* Serv., *Diponthus communis* Brun., and *Dichoplus elongatus* Giglio-Tos. It might be of interest, however, to know that each of these, aside from the *paratensis*, becomes locally destructive at times. This fungus, like *Empusa*, flourishes best during warm, humid weather.

Having obtained such satisfactory results in transmitting this disease to other locusts while conducting experiments in Argentina, a quantity of dead fungus-covered insects, like those described above, were gathered and brought back to the United States for use in attempting to destroy our North American species. Accordingly, in July and August, 1898, large numbers of several of our most common *Melanopli* were gathered and placed in breeding cages along with a goodly supply of green food and the bodies of the dead fungus-covered insects. The powdered bodies of such dead locusts were also strewn over the food and moistened earth at the bottom of the cages. In addition to these, similar experiments were attempted in fields where our native locusts were exceedingly numerous, but in all cases these experiments failed to show a single instance of the possible transmission of the fungus to our native species.

More recent attempts at obtaining an artificial growth of this South American locust-killing fungus on various media in the laboratory have likewise proved utter failures, the reason for this being, no doubt, the great age of the material at hand.

Notwithstanding the failures in the experiments just recorded, this, in the opinion of the writer, is one of the most promising locust-attacking fungi, since it was found to withstand considerable variation in climate and to attack at least four widely different insects. Then, too, its close relationship with the so-called chinch-bug fungus (*Sporotrichum globuliferum*) gives us some reason for encouragement in the future.

On July 17, 1900, a letter was received from Mr. George W. Martin, Sterling, Colo., who had undertaken some experiments with the South African locust fungus, a supply of which was furnished him from Washington. This letter reads as follows:

DEAR SIR: I have succeeded in killing a large number of grasshoppers on 60 acres of alfalfa, covering the ground with them for one-fourth mile. The disease is still spreading and is now 500 yards from where the infected ones were placed. I do not see why it will not kill all of them. I use corn meal, 2 parts sugar, 1 part, for dose, feeding at 4 p. m., again 6 p. m., putting them out at 7. I drive over the fields to be infected. The fungus seems to be better a week old than earlier.

Yours, truly,

GEORGE W. MARTIN.

A visit to the locality, as already stated, revealed the fact that although several species of native locusts were dying in large numbers, yet, contrary to the rule with insects that had been attacked by *Empusa*, these Colorado "hoppers" all fell to the ground instead of remaining fastened to the vegetation. About the same time, and also somewhat later in the season, other reports were received of similar epidemics occurring among the grasshoppers in localities where no infection of any kind had been distributed. This year again other reports of similar epidemics occurring among these insects were received here at the University of Nebraska. One of these was so remarkable in nature that a representative of the experiment station visited the locality to make an investigation. He was also requested to secure specimens of the dead and dying insects so as to ascertain, if possible, the cause of the epidemic. Other material was received at the station from correspondents, and from both of these lots of dead insects there was obtained, among other things (as *Spirillum* and *Bacterium*), a *Sporotrichum*, the specific identification of which was not ascertained at the time, as the botanists were then all away on their summer vacations. Since their return school duties have prevented their giving the necessary time to the matter, hence we can only suggest that this may be a second species of the genus which attacks locusts.

While most of these local outbreaks among our native locusts occur in moist localities, such as irrigated fields and bottom lands, the one near Ogallala, Nebr., was in a field which irrigation did not reach, and came at a time when little or no rain had fallen for several weeks. The species of locusts found generally among the dead were *Melanoplus differentialis*, *M. bivittatus*, *M. atlanis*, *M. femur-rubrum*, *M. packardii*, *Spharagemon collare*, *Brachystola magna*, and *Dissosteira carolina*; these were numerous in the order named; a very encouraging record when we take into consideration the differences in the habits and structure of these insects. All the occurrences of this last-named disease were in fields of alfalfa.

The isolation of this fungus came so late in the year, and at a time when other matters were so pressing, that further work with it was, for the time being, impracticable. It is impossible, therefore, to predict its probable future value as an artificial factor in the control of the locust pest in the region where it was found.

The *Sporotrichum globuliferum* is reported as having been successfully used against the different species of destructive locust in Algeria during 1899, but whether the identification of the fungus concerned is reliable is not known.

CONCLUSIONS.

After having spent considerable time in experimenting under various conditions and in different regions, as well as in the study of the researches carried on by others, it is the opinion of the writer that

fungous diseases as a means of killing off insect pests is greatly overestimated. Especially is this true with reference to their use against destructive locusts. The chief objections are the difficulties with which pure cultures are obtained and later transmitted to the insects to be destroyed, and the frequent adverse influence of climatic conditions.

Much of this false notion as to the absolute effectiveness of inoculation as a cure-all, which has gained a firm lodgement in the minds of so many people throughout the land, is, no doubt, due to the careless way in which agricultural and other newspapers of the country make definite statements on incomplete information. Then, too, very frequently contributors to such papers write concerning matters they know little or nothing about. This sort of business on the part of the press certainly places the economic entomologist in a peculiar position since it creates a misunderstanding between him and the people in whose interest he is supposed to labor.

Were the writer required to give his opinion as to which of these different fungi seems the most promising, he would, without hesitation, say, "The native one." He would say this, because the importation of these locust-killing fungi from one country into another depends greatly on the similarity which exists in the climatic conditions of the countries concerned, in the relationship of hosts to be considered, and in the ease with which the fungi can be handled in the laboratory. Between the *Empusa* and *Sporotricha* the latter seem the more preferable, because they are more readily handled artificially, growing, as they do, quite readily on different culture media.

THE CONFLICT OF THE RUSSIAN ZYEMSTVOS^a WITH THE ENEMIES OF AGRICULTURE.^b

By V. MORACHEVSKI.

[Abstract by Dr. Peter Fireman.]

Not the measures employed by the individual farmer in his fight against the animals and insects injurious to agriculture are described in the present article, but those adopted by the local self-government organs in Russia.

GRASSHOPPERS (ACRIDIDÆ).

(a) *Pachytylus migratorius*. It is at present accepted as proved that the islands of some rivers (Ural, Volga, Kuma, Kuban, Terek, Manich, Egorlik, Don, Dnieper, Danube, and Sarpa) serve as nurseries for this insect. Such islands furnish an enormous store of food for grasshop-

^a Zyemstvo—A governmental body in Russian provinces and local districts, elected by the people. It consists in each case of a council and an executive board.

^b (Syelskoye Khozyaistvo e Lyesovodstvo (Agriculture and Forestry), vol. 193, 1899, April, pp. 183-208; vol. 194, 1899, August, pp. 193-226, September, pp. 445-454.)

pers, sufficient in the great majority of cases to maintain them from the time of their hatching to their death. Moreover, on these islands they are safe from their natural enemies. Therefore, the investigators of the grasshoppers, as well as some of the *zyemstvos*, have arrived at the conclusion that radical measures for preventing the calamities caused by the incursions of these insects must be directed not so much toward the destruction of the insects as toward the conversion of these islands into cultivated lands.

In the appearance of the grasshoppers in enormous numbers some periodicity has long been observed.

In the Taurida government some of the *zyemstvos* took up the combat against the grasshoppers in 1877. The rules which are at present obligatory in the contest in the whole province were elaborated by the provincial *zyemstvo* and confirmed by the Minister of the Interior. The work is paid for according to a scale fixed by the district *zyemstvos*. For the performance of the work all persons of the lower classes are required to present themselves (peasants, workingmen, and the like, not excluding the women and children above 10 years of age). Each relay of workmen can be held not longer than three days. The council of the district *zyemstvo* elects special organizers for stated sections of the district, whose duty it is to watch the appearance of the grasshoppers in the district, to study the extent of the area infested with the eggs of the grasshoppers, to keep the district as well as the provincial *zyemstvo* informed about their observations in this regard, and to personally participate and superintend the work of destroying the insects. In 1896 there were 17 such organizers in the Simpheropol district, with a compensation of 3 rubles per day during the time of fighting the grasshoppers.

The Bessarabia government began the contest in 1876 and stopped it in 1887, since when the grasshoppers have not appeared.

In the Kherson government the provincial *zyemstvo* conducts the fight against these insects as well as against others, and *sussliks* (*Spermophilus citillus*), covering the expense by collecting a tax of one-half cent per *dyessyatina* (2.7 acres).

In the Voronyezh government the provincial *zyemstvo* in 1882, in view of the fact that the grasshoppers deposited their eggs in the autumn over an extended area, especially in the Novo-Khopyor district, petitioned the Imperial Government to defray the expenses of fighting the grasshoppers from the general funds of the Empire, to appropriate for this purpose 1,000,000 rubles, and to impose a natural tax. Meanwhile the Novo-Khopyor district *zyemstvo* was directed to urge the land owners to plow up those places where the eggs were deposited. The Minister of the Interior, however, refused to grant to the provincial *zyemstvo* the subsidy of the Imperial Government, but agreed to loan that sum to the *zyemstvo*. In 1883 the grasshoppers made

their appearance in the spring. They were combated very energetically, with the cooperation of the police, local population, and six battalions of soldiers. At an expense of 52,000 rubles the *zyemstvo* destroyed completely the grasshoppers in the province.

In the Oryol government all the work directed to the destruction of the grasshoppers is divided between the provincial *zyemstvo* and the district *zyemstvos*, the duty of the former being the ascertainment of the places infested with the eggs of the insects, the instruction of the population in the methods of combating them, and a general supervision over the carrying out of all the operations, while the duty of the district *zyemstvos* is the immediate execution of those operations.

The Tambov government in 1893 petitioned the imperial administration to consider the destroying of the grasshoppers as a duty of the whole nation. The minister of the interior replied that similar petitions were received repeatedly from *zyemstvos*, but were invariably declined by the minister of the interior, with the concurrence of the ministry of finance, on the ground that, according to the existing laws, measures for the destruction of the injurious insects are incumbent upon the *zyemstvos*. The executive board of the provincial *zyemstvo* then organized the fight against the grasshoppers, a fund of 100,000 rubles being appropriated by the *zyemstvo*. The wages were fixed as follows: To a workingman with a horse, $12\frac{1}{2}$ cents a day; to one without a horse, 5 cents a day; for 36 pounds of grasshoppers collected, $12\frac{1}{2}$ cents.

The *zyemstvos* of the Ekaterinoslav, Chernigov, Kursk, Ryazan, Samara, and Penza governments had also to fight grasshoppers, which they did more or less successfully.

(b) *Caloptenus italicus* (Italian grasshopper). This insect appears in some places in enormous quantities. In three districts of the Saratov government the peasants destroyed in one season 36,000 poods (1 pood = 36 pounds); on one estate alone during five weeks 15,000 poods were collected; in the Bobrov district 40,000 poods were destroyed.

In 1897 the following regulations were adopted by the Bessarabia government, with the approval of the imperial administration: A natural tax and a money tax are fixed. The natural tax is imposed on persons belonging to the lower classes (peasants, workingmen, etc.), not excluding women and children; all these persons must do the work of destroying the Italian grasshoppers, without compensation, within a radius of 7 versts (1 verst = $\frac{2}{3}$ mile); if called to more remote places they receive a certain compensation fixed by the provincial *zyemstvo*; each relay of workingmen can not be held longer than three days. The money tax is imposed upon all the landowners who are not subject to the natural tax. The money so collected goes to cover the expenses incurred in fighting the grasshoppers, in payment to the

owners for their crops destroyed, in payment of the workers who came from places farther than 7 versts, etc. For the crops destroyed while fighting the insects the owners are reimbursed to the amount of the value of the seeds, the cost of cultivation, and the rent for the land.

In the Orgueyev district, over an area of 2,000,000 acres, the fight against the Italian grasshoppers in 1897 required more than 26,000 adult workers, 20,000 boys, and over 2,000 wagons.

In the Kherson government the Odessa district *zyemstvo* spent in fighting the Italian grasshoppers in 1895, 4,000 rubles; in 1896, 20,000 rubles (paying to the workingmen 25 cents per day, young lads 12½ cents, to children 6½ cents, and for man and wagon 50 cents, and 12½ cents, besides, for each pood of grasshoppers killed and collected); and in 1897, 9,500 rubles.

In the Taurida government the Dnieper district *zyemstvo* reports that the fighting of the grasshoppers pursued by it at a great outlay of money during three years is quite successful, as witnessed, among other things, by the considerable falling off of the expenses: The expenditures in 1894 were 37,000 rubles; in 1895, 9,000 rubles; and in 1896, only 2,760 rubles.

The Kursk, Ryazan, Voronezh, and Saratov governments fight the Italian grasshoppers by similar methods.

(c) *Gomphocerus sibiricus*, *Stenobothrus elegans*, *Stenobothrus melanopterus*, *Psophus stridulus*, *Bryodemus tuberculata*, *Stauronotus cruciatus* or *Stethophyma flavicosta*, *Stethophyma fuscum*, and *Pezotettix pedestris*.—These do much damage, chiefly in the east of European Russia, in the Ural region, and in western Siberia.

The *zyemstvos* of the Ufa, Vyatka, Perm, Nizhni Novgorod, and Kostroma governments conduct the fight against these insects on lines similar to those described with regard to the grasshoppers.

MEANS OF COMBATTING THE GRASSHOPPERS.

(1) Shallow replowing or harrowing in the autumn of those places which are infested with the eggs of the grasshoppers, etc., is one of the best and most effective measures. By shallow plowing, 2 to 2½ inches deep, the eggs are turned out to the surface of the ground and perish, partly from atmospheric conditions and partly from birds.

(2) Burning up by means of straw is practiced with great success to the destruction of the larvæ of the grasshoppers. The straw is usually piled up in the field in a few places; the larvæ gather to these piles toward evening in large numbers in search of drier places; the straw is then ignited simultaneously from all sides. In extreme cases, when it is too late to drive out the insects from among the crops, the crops themselves are burned up. For cereals thus destroyed the owners

receive from the *zyemstvos* an indemnity, which is usually somewhat less than the real value of the burned crop.

(3) The larvæ are sometimes destroyed by crushing with shovels, rolls, bundles of brushwood, etc. The brushwood drags give the best results. The laborers surround a certain section and drive the insects toward the center. When the circle becomes small a few brushwood drags are drawn along the circumference of the circle, describing circles of smaller and smaller diameter each time.

(4) The driving of the larvæ into ditches and destroying them there by crushing or burning is not effective in the case of adult insects or too young larvæ (the latter remaining immovable when the attempt is made to frighten them up by brooms, etc.). Protective ditches used for preventing the insects from passing over into the unattacked fields must be deep and well guarded to be effective.

(5) Collecting by means of bags, sheets, etc., is also much practiced. Certain trap bags have been invented and are very effective.

(6) Some apparently successful experiments were also made in destroying the insects by infecting them with the fungus *Empusa grylli*.

OTHER INJURIOUS INSECTS.

The *zyemstvos* have so far confined themselves principally to the combating of the *sussliks* and of the grasshoppers (including in the latter a number of allied insects), not taking up at all the contest against other insects equally injurious to agriculture, or taking it up only now and then, without regularity or system, in years of very great ravages.

(a) *Agrotis segetum* and *Agrotis exclamatoris* are the most dangerous and most common enemies of the winter cereals. Their caterpillars are usually called (in Russia) the winter worms. Against these insects a fight is conducted only by the *zyemstvos* of some northeastern governments—Kostroma, Perm, Kazan, and others. Only the provincial *zyemstvo* of the Kostroma government has imposed a natural tax. In this government peasants have to appear with plows, brooms, and shovels for two days; within a radius of 7 versts they get no remuneration, but beyond that distance a certain daily wage.

(b) *Anisoplia austriaca* (grain beetle).—The Imperial Government proposed in 1879 to all the southern *zyemstvos* to hold an extraordinary meeting in order to discuss the question of the grain beetle. All the *zyemstvos* (viz, of the Kherson, Poltava, Bessarabia, Taurida, and Kharkov governments, and also the Don *zyemstvo*) gave their opinions in favor of the mechanical methods of fighting the beetle, and petitioned the Imperial Government to prohibit the use of ropes and to declare the measures obligatory for all the southern governments. The Imperial Government granted the petition, making the following tax, as a temporary measure, obligatory for the enumerated govern-

ments during a period of two years: Persons of the lower classes must appear for three days' work without compensation at a distance of 7 versts and with compensation at a greater distance, not exceeding 20 versts; upon persons of the higher classes, on the other hand, a money tax is levied, the amount of the imposition per dyessyatina (2.7 acres) depending on the value of the work performed by the persons of the lower classes. The use of the rope was prohibited by the same law. After the lapse of two years the law was not renewed, each government conducting the contest according to its discretion. The Taurida and Ekaterinoslav governments leave the fight of the weevil to the population, and allow the use of the rope. The Kharkov government has imposed a tax of 1 garnts (2.88 quarts) of weevils from each dyessyatina (2.7 acres) under rye, wheat, and barley; for each garnts not presented a fine of $12\frac{1}{2}$ cents is imposed.

The means of fighting the weevil employed by the *zyemstvos* are almost all mechanical: (a) Collecting the weevil with the hands or with specially designed machines, and (b) frightening off the weevils by means of a rope.

(c) *Cecidomyia destructor* Say.—The only measure enforced by the *zyemstvos* in fighting the Hessian fly consists in not allowing the early sowing of winter crops.

THE TOBACCO STALK WEEVIL.

(*Trichobaris mucorea* Lec.)

By F. H. CHITTENDEN.

In a consideration of the potato stalk weevil, *Trichobaris trinotata* Say., which was treated somewhat in detail in Bulletin No. 33, new series (pp. 9–18), it was remarked in defining the food habits of this species that tobacco and tomato appeared to be exempt from its ravages, although nearly all other Solanaceae growing within its range were attacked. Before the bulletin in question had appeared in print we received a communication from Mr. Lawson H. Shelfer, tobacco expert of the Bureau of Soils, and located at Willis, Tex., that a related species of weevil was greatly injuring tobacco in that section. Our correspondent first wrote in regard to this species, transmitting adults, and in the following months sent much material and many valuable notes on the habits of this insect and the nature of its ravages. The remarks which follow, on the insect's life history and habits, are based mainly upon Mr. Shelfer's letters and the material received from him.

The larva of this species also, as might be expected from its close relationship to the potato stalk weevil, inhabits the stalk of tobacco and also the main ribs of leaves, sometimes completely severing them or injuring them so badly that the winds which blow almost constantly in that region break them off and thus greatly weaken the plant.

This weevil first appeared, according to the testimony of residents of that vicinity, in 1898, and has become more numerous each year. At the date of first writing, May 20, from 2 to 6 beetles were found on single plants, frequently in pairs. It was concluded, as a result of conversation with many local growers, that the tobacco crop had been attacked even earlier than the specified date, but the cause was not definitely known.

May 28 some tobacco plants showing infestation were sent to this office. It was discovered a few days before this time that nearly every plant in a four-acre field was affected. In some neighboring fields it was impossible to find a stalk that did not contain one or more larvæ, but all fields were not so badly affected.

The larva is locally known as "pith worm," from its habit of boring through the length of plants.

The beetles were also stated to be doing great damage to tobacco.

June 12, Mr. Shelfer stated that the beetles were still cutting the leaves and depositing eggs. Owing to the fact that twenty-six days had elapsed at that time since rain had fallen and many nights were without dew, the tobacco crop suffered much, and more especially when this insect was at work in the stalks. During the last week of June and first of July we received considerable material from our correspondent, the insect being present in the three stages of larva, pupa, and adult at this time. In some stalks the pupal cell was constructed 4 inches from the root system, while in others on a level with the surface of the ground. It is evident that in tobacco this insect works in a different manner from that which it employs in other plants which it may infest, the reason being the very woody condition of the lower portions of the stalks. It is evident also that the larvæ, after attaining maturity or thereabouts, turn and bore upward for the construction of their transformation cells. The lowest individuals will mature first, and those which form their cells higher will mature much later. As a consequence there will be intervals of a week or more between the time of their transformation. Thus it happens that the older individuals must wait for the younger ones to make their exit, since there is hardly space for the former to pass the latter. Some of the insects penetrate to the very tops of the stalks.

Jamestown weed, which we have record of this insect attacking, was a comparative rarity in that section of Texas, and no other solanaceous plants could be found growing wild within half a mile of the infested fields. At other points (Liberty and Woodville, Tex.) this weed was found, but no weevils, this verifying an opinion hazarded by the writer that the insect was local as well as periodical as regards injuries.

Mr. J. A. Blohm, of Willis, verified Mr. Shelfer's account as to injuries of this stalk weevil, his experience practically duplicating that of our correspondent in most essential particulars.

Attack was at first attributed to improper farming.

September 5, 1902, Mr. Shelfer called at this office and furnished the writer with some additional information on the insect's occurrence and life history. Tobacco was first set out April 8, and the beetles were observed at work the following day, as a rule in pairs, attacking the leaves, which soon after attack began to droop. After the mid-ribs had been eaten for some time the leaves curled over, and under this protection the beetles congregated for feeding. The beetles, as well as larvæ, were still in the field the first week in September.

DESCRIPTIVE.

The tobacco-destroying species of weevil, *Trichobaris mucorea* Lec. may be readily separated from the potato species, *T. trinotata* Say, by its much larger size. The former will average one-fourth of an inch or a little longer (5-6^{mm}), while the latter does not exceed three-sixteenths of an inch, averaging about one-sixth inch or a little smaller (3-4.5^{mm}). The tobacco species is, moreover, a little more robust and of more uniform size, and is distinguished, according to Casey, "by its rather depressed upper surface and the subdentate area at the sides of the prothorax beneath." Also by the "pronotum densely and confluent punctate, sometimes longitudinally rugose, the sides more or less feebly sinuate just behind apical third; antennal club more slender and elongate, less abrupt, the outer funicular joints more transverse; pronotum with a narrow impunctate median carina."

In *T. trinotata* the pronotum is simply punctate and without an impunctate and subcarinate median line, as in *mucorea*, and the antennal club is robust and abrupt. In a large series of specimens, such as the writer has at the present writing, it is seen that there is also a difference in color. All of the specimens of *trinotata* are darker, the pubescence being darker gray than in *mucorea*. There is no observable difference in specimens collected in the field and those taken from the stalks of eggplant the first week of September. In hibernated individuals of *mucorea* the scales are very pale, nearly white, while in those which have recently issued from stalks they are dull, somewhat yellowish brown.^a In all specimens of *mucorea* there is an apical line of yellowish pubescence on the thorax, forming a collar above the head. This collar is scarcely at all indicated in *trinotata*, and the color of the scales here are of the same uniform gray as of the entire upper surface.

INJURY IN FLORIDA BY A RELATED SPECIES.

July 14, 1902, Mr. William M. Corry, Quincy, Fla., wrote, in response to inquiry, that at various times in previous years—though not in

^aThis difference in coloration has been noted in another species of scale-covered weevil, *Ceutorhynchus rapæ* Say, Bul. 23, n. s., p. 43.

1902—he had observed affected stalks in fields of tobacco there, and when the leaves were broken off it was found that a hole was in the center, caused by a small insect known there as “the borer.” The insect seemed to start at the root and make its way gradually up in the heart of the stalk, its presence being indicated by the leaves dropping and the stalk gradually withering and turning yellow.

There can be no reasonable doubt that the species in question is *Trichobaris insolita* Casey, a species rather commonly found in that portion of Florida.

DISTRIBUTION.

In defining the distribution of the potato stalk weevil it has been said that that species was rather generally distributed throughout the Carolinian and Austroriparian regions, and that it was found westward to Texas. Such a statement has previously been made by Casey and probably others, and it may be that the insect really inhabits Texas, but in a series of 34 specimens at present available Texas-labeled individuals are not in evidence.

Trichobaris mucorea is represented in the national collection and others at present under observation by upwards of 50 individuals, from which the following locality list is taken: Columbus and Willis, Tex.; Los Angeles, Kern County, and elsewhere in California (no definite locality); Tucson, Galiuro Mountains, San Rita Mountains, Catal Springs, and Oracle, Ariz. LeConte records the species from Cape San Lucas, Lower California, and there is little doubt that it occurs elsewhere in Mexico. The type specimen was found near Fort Yuma, Cal. (Proc. Acad. Nat. Sciences, Phila., 1858, p. 59.)

METHODS OF CONTROL.

In spite of the close relationship of this species to the potato stalk weevil, it is very evident that we have an entirely different problem to solve. The similarity of the insects is structural. The habits are materially different; for whereas the potato weevil has a definite time of appearance and disappearance, from April to May, and again the following year at the same time, we see no more of the insects until after they have laid their eggs and the larvæ have transformed to pupæ and thence to adults in the stalks. Here they remain during the winter. The tobacco weevil, on the contrary, evidently escapes from the stalks after the tobacco leaves have been cut, and hibernates in other places.

Paris green, Mr. Shelfer has observed, applied as a spray by means of a knapsack outfit, will kill the beetles, and he is of the opinion, in which the writer concurs, that if an arsenical is used at intervals during the season at the proper time, beginning with the time that plants are set out, the insect may be kept under control.

The following suggestions for another season are made:

After the leaves are cut the stalks should be destroyed as promptly as possible, and the entire fields should be cleaned of refuse; and this applies also to barns and other places where the tobacco is stored. If this be done systematically over the entire affected area it will leave very few insects to combat the following year.

The first appearing insects could be attracted and successfully dealt with, there is no doubt, by setting early plants as traps here and there over the area to be grown in tobacco. Their growth could be stimulated, and they could be protected from insects and the weather until ready for use, by covering them with square frames covered with cheese cloth or similar material. A few days before planting the main crop the covers should be removed and the plants thoroughly coated with a spray of some arsenical.

Before setting out the main crop the plants should be dipped in a solution of arsenate of lead, prepared at the rate of 1 pound of poison to 100 gallons of water. This would not scorch the plants, and it would be preferable to Paris green, as it remains longer, requiring more rain to wash it off. In a week or ten days, according to the growth of the plant, a second spraying should be made, and for this purpose either arsenate of lead or Paris green and Bordeaux mixture can be used.

It is suggested by way of experiment that one plat of, say, 25 or more plants be sprayed with arsenate of lead; a second with Paris green, 1 pound to 150 gallons of water; a third with Paris green at the same rate, with the addition of Bordeaux mixture used instead of lime as a diluent; and the fourth, with Bordeaux mixture alone. It is not known to what extent Bordeaux mixture would prove repellent to this weevil (possibly not greatly), but if sufficiently distasteful it would drive the insects from the plants treated with it to others which should be poisoned with Paris green alone.

THE LEAF-MINING LOCUST BEETLE, WITH NOTES ON RELATED SPECIES.

BY F. H. CHITTENDEN.

The foliage of the common, yellow or black locust tree (*Robinia pseudacacia*) is subject to the attack of a leaf-beetle, sometimes called in literature the locust Hispa (*Odontota dorsalis* Thunb.) and which we may call the leaf-mining locust beetle to distinguish it from several other forms of insects, mostly the larvæ of Tineidæ, which also mine the leaves of this tree, and from other beetles which attack the trunk and other portions of the tree. Injury by the species under discussion is due mainly to the work of the larvæ, although the beetles also assist.

Damage usually becomes manifest some time in July in the more northern States, and southward earlier, in June. In cases of severe attack the leaves turn brown as if scorched by fire. Injurious attack is not often brought to the notice of economic entomologists, which is rather remarkable considering that the locust is of great value as a timber tree, for posts, etc., though of less importance as a shade tree than elm, oak, maple, and others with which everyone is familiar. Thus it happens that although year after year this insect has done much harm to the locust, where this tree is of value, comparatively little has been published concerning the insect's ravages, its life history and habits.

Like many other insect pests, it is subject to considerable fluctuation in numbers, in some years being quite destructive while in others it attracts little notice. It is nearly always more or less troublesome to the locusts in Maryland, Virginia, and the District of Columbia, and in recent years has been reported as more or less destructive in neighboring States. Injury has been reported in West Virginia from 1890 to 1897, in New York and New Jersey in 1896, in Maryland from 1896 to 1899, in Ohio and Kentucky in 1897, in Pennsylvania and Kentucky in 1898. These reports probably do not by any means sum up the entire area infested during the past ten years. In 1898 this beetle did more than usual damage over a considerable portion of this territory.

In most seasons this beetle does little more harm to the locust than to mar its beauty as a shade tree, but in years of its greatest abundance it is probable that trees are so badly weakened by the combined ravages of this and other leaf-miners that the result is practically the same as that of defoliation and the trees are so weakened that they readily succumb to disease, to unfavorable atmospheric conditions, and to the destructive work of different species of borers, such as the painted locust borer (*Cyllocus robiniae* Forst.), which is of still more importance as an enemy of this tree.

In the vicinity of the District of Columbia the damage effected by this leaf-miner is frequently as bad as reported elsewhere, and we have observed locust groves where the injury was almost entirely due to the work of the beetle, while in others the Tineid leaf-miners were more numerous. As a rule, however, this locust beetle is more abundant about Washington than all of the leaf-mining Tineidae, as well as other locust pests, taken together, and its importance in economic entomology is deserving of a more detailed consideration than has hitherto been given to the public.

Injury is usually most severe to young trees and to such as have low, vigorous branches, and to others growing on the edges of sunny lawns and in similar locations. There are, however, some striking exceptions. In many localities such plants suffer greatly year after year. Taller trees, on the contrary, are much less subject to injury.

In speaking of damage effected by this leaf-miner, Chambers (Amer. Ent., Vol. III, p. 61) says:

The young trees seem to suffer most, as the insect seems to prefer their foliage; and large old trees seldom exhibit the burnt appearance of the young groves. Young shoots growing up around an old trunk will sometimes have nearly all of their leaves blistered, while few, comparatively, on the old tree will be injured.

DESCRIPTIVE.

Few species among our native Coleoptera exhibit more striking coloration than *Odontota dorsalis*,^a so that with the accompanying illustration (fig. 3, *a*) and description even an inexperienced observer can not fail to recognize it.

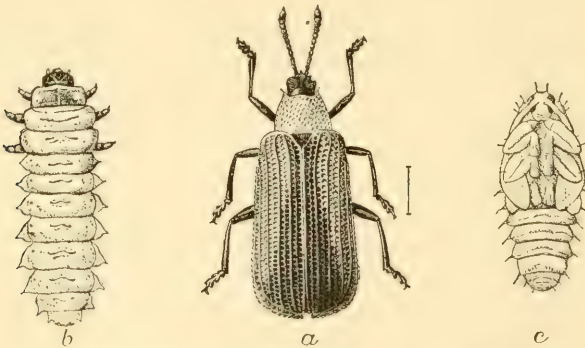


FIG. 3.—*Odontota dorsalis*: *a*, beetle; *b*, larva; *c*, pupa—5 times natural size (original).

The beetle.—It is elongate in form, moderately convex, only moderately shining, the color of the dorsal or upper side being bright orange red with the head and a vitta or stripe along the suture of the elytra or wing cases black. The ventral or under side, including the legs, is also black. The black sutural vitta occupies usually about one-third of the width of the elytra and widens behind, but sometimes it is much narrower and of equal width and still more rarely widest at the base. The structural characters which, besides the coloration, distinguish *O. dorsalis* from other species of the same genus are as follows: Form rather slender, not cuneiform; elytra of equal width, each having ten series of punctures and three of the interstices forming elevated costae.

It measures a little less than a fourth of an inch in length (5–5.5 mm.) and is less than half that in width (2.2–2.4 mm.) at its widest part.

The egg is short, oval in outline and flattened on two sides, its color when freshly

^a As this species has been given other names than the one here used, a word should be added in regard to nomenclature. The specific name *dorsalis* was proposed first by Thunberg in 1805 (Götting Gel. Ang., p. 282); in 1808 Olivier redescribed it as *Chrysomela scutellaris* (Ent. Hist. Nat., Coleop. Vol. VI, p. 771), and Harris also described the species as new, using the name *Hispa suturalis*, which was first introduced by the Rev. F. V. Melsheimer in his Catalogue of the Coleoptera of Pennsylvania, published in 1806 (p. 15, no. 308), and seems to be based on an erroneous identification of our species with the *Hispa suturalis* of Fabricius.

laid being milk white, with the shell extremely thin and pliable. A very fine net-like sculpture is barely visible even under a strong magnifying glass.

The larva.—The more obvious characters by which the full-grown larva (fig. 3, b) may be distinguished are as follows:

Body depressed (but not flattened), elongate, very little tapering posteriorly, glabrous, color yellowish white, the head, larger portions of first thoracic segment, upper side of anal segment, and the legs brownish or blackish. Head subquadrate, about half as wide as the first thoracic segment, brown, shining, impunctate, with a deeply impressed median line. First thoracic segment more than twice as wide as long, a little longer than the head, distinctly bisinuate at the anterior margin, sides strongly rounded; a large brown spot divided by a narrow median line occupies the greater portion of the upper surface, but does not reach the posterior and side margins. Second thoracic segment a little shorter, but wider than the first, sides very strongly arched but not gibbous, surface uniformly whitish; third thoracic segment equal to the second. First abdominal segment a little shorter than the last thoracic one and also a little narrower, but produced on each side into a triangular, semitransparent tubercle, capped with a more horny point which in its turn terminates in a short spine. Second, third, and fourth abdominal segments equal to the first; on the following segments (which are slightly longer than the first) the lateral tubercle is directed gradually more backward, the anal segment is unarmed, shorter and much narrower than the preceding, subtruncate at tip, its upper side being of a brown color.

The general color of the dorsal surface is not uniform, but variegated by the transparency of the skin as the fat corpuscles of the body appear on the surface as yellowish-white spots, the rest of the body being grayish white. The sculpture of the dorsal surface (excepting head and anal segments, which are smooth) consists of a very regular fine granulation and besides this of vague impressions arranged as follows: On the first thoracic segment an undulating impression each side on the disk; on the two following thoracic segments a long transverse median impression accompanied each side posteriorly by a foveiform impression; on the abdominal segments a transverse median impression and another oblique one each side, causing the spiracles to be placed upon a kind of blunt tubercle.

The ventral surface is colored like the dorsal and only the head and median portion of the first thoracic segment is brown, and the general sculpture is like that of the upper side, legs being brownish or blackish, stout, and widely separated.

There are nine pairs of rather conspicuous stigmata, all visible from above and situated as follows: One pair at the anterior angle of the second thoracic segment, one pair on each of the first seven abdominal segments, each stigma being at the base of the lateral tubercle a little before the middle of the segment; the ninth pair is situated on the dorsal side of the anal segment. The thoracic and anal stigmata are larger than the intermediate ones.^a

^a It is interesting to observe that most leaf-mining larvæ of different families or even of different orders of insects exhibit a strong uniformity in general appearance, viz, a more or less depressed body, the head being much narrower than the first thoracic joint, while all joints of the body (excepting head and anal joint) are strongly arched at the sides and often tuberculate or even spinose. Thus the larvæ of our leaf-mining Buprestide (genera *Brachys* and *Trachyscelus*) and *Rhyneophora* (genus *Orchestes*) have an unmistakable resemblance to our Hispine larvæ, and all of these agree in shape with the numerous Tineid leaf-miners.

There can be no mistake about the number and position of the stigmata, and the account given by Chapuis & Candeze appears to be based upon a wrong interpretation of Harris's figures, entirely ignoring the correct description of that author.

The young larvæ differ from the mature ones by being more contracted, thus appearing more strongly tuberculate at the sides. Moreover, very young larvæ are entirely whitish.

The pupa (fig. 3, c) is at first whitish, but soon assumes a uniform rich honey color. In general shape it resembles the full-grown larva, only a little shorter and somewhat more convex. The head has become more convex and especially wider in comparison with the first thoracic segment; the second and third thoracic segments have of course changed the appearance of the wing pads, which are longitudinally striate and bent downward along the sides of the body, resting between the second and third pairs of legs and reaching with their extremities to the posterior end of the first ventral segment. The abdomen still shows the lateral tubercles so conspicuous in the larva and these tubercles are furnished each with two or three stiff bristles. The edges of the median transverse impressions on the dorsal surface of the abdominal joints of the larva are in the pupa much sharper, ridge-like, and also furnished with sparse bristles. The fourth abdominal spiracle is replaced by a long stout spine directed backward. On the ventral surface the armature of spines is even more conspicuous than on the dorsal, each segment having a sharply raised transverse line which is sinuate and more raised at the middle and there furnished with five or six setiferous tubercles. On the penultimate segment the transverse line is not sinuated and is furnished with eight tubercles, the two median ones being much less prominent than the lateral ones. The anal segment is also furnished with two obsolete transverse lines and with a few inconspicuous tubercles.

This array of bristles and tubercles enables the pupa to move rapidly forward or backward by a wriggling motion of the abdomen. The power of locomotion exhibited in this pupa is really astonishing; in fact, the pupa is much better afoot, so to speak, than the larva.^a

The mine produced by the larva has not hitherto been described so that it may be distinguished from the mines produced by the various leaf-mining Tineidæ which are usually working in company with it. As already stated, the beetle larva consumes the whole of the parenchyma within its mine, thus causing the mine to be equally visible on both sides of the leaf, whereas in the case of the Tineidæ the larva destroys only a thin layer of the upper portion of the parenchyma, causing the mine to be invisible on the underside of the leaf. The Tineid larva very neatly separates the epidermis from the parenchyma so that not a particle of this last is left adhering to the skin-like epidermis forming the roof of the mine, and this roof is of a uniform pale buff color strongly contrasting with the green of the leaf. On the other hand, the larvæ of the beetle accomplish their work much less carefully; numerous small particles of the parenchyma are left adhering to the epidermis, and consequently the latter forms a much thicker covering to the mine than in the case of the Tineidæ. The color of the mine is a pale green slightly tinged with brown, its surface

^aThe power of locomotion in the pupa becomes still more remarkable if we take into consideration that the pupa, which always remains within the mine, has really no occasion or opportunity to make use of it, unless we except the possibility that by wriggling about in their mines the pupæ might succeed in evading parasitic or predaceous attack.

being tightly roughened and never so smooth as in the Lepidopterous mines. In outline the beetle-larva mine is neither uniformly rounded nor provided with finger-like processes, but irregularly undulated. As soon as the larva has left the mine or has changed to pupa, the affected part of the leaf dries up and assumes the dismal brown color already alluded to.

GEOGRAPHICAL DISTRIBUTION.

This species is native to North America, and apparently partial to the upper austral life zone, but its full distribution does not appear to have been clearly defined beyond published statements that it occurs in New England and the Middle, Southern, and Western States. Northward, we know of its occurrence in Massachusetts, Connecticut, and Canada, but it does not appear to have ever been taken in Michigan, a State which has been rather thoroughly collected over by Messrs. Schwarz and Hubbard. In Missouri, although numerous collectors and observers have made collections in that State, the species appears to be rare, although taken in two localities. It will thus be seen that although the southern and western range is practically limited by the States of Virginia, Kentucky, and Missouri southward, and by Missouri also westward, the precise limits of its range remain to be determined.

In his Check List of the Forest Trees of the United States (Bul. 17, Div. Forestry, U. S. Department Agr., 1898, p. 82) Mr. George B. Sudworth speaks as follows regarding the distribution of *Robinia pseudacacia*:

Range.—From Pennsylvania (on the Appalachian Mountains from Locust Ridge in Marion County) to northern Georgia. Widely naturalized through cultivation and other agencies throughout the United States east of the Rocky Mountains; possibly indigenous in parts of Arkansas (Crowleys Ridge, etc.) and eastern Indian Territory; also in the Great Smoky Mountains of eastern Tennessee (Sevier County).

From the entomological record it would seem, therefore, at least at the present writing, that this locust hispid has a more limited range of distribution than its food plant, which is not infrequently noticed among insects and which occurs also in another species of Hispidæ, viz, the trumpet-creeper leaf-miner, *Octotoma plicatula*, which will be considered later on in the present article.

The following is a list of localities from which the species has been received at this office or is known to the writer or recorded:

Massachusetts; Connecticut; Allegheny, York, Pa.; Coney Island, Rockaway Beach, Yaphank, L. I., N. Y.; New Jersey (throughout the State—Smith); Tennallytown, Washington, D. C.; Oakland, Bladensburg, Glen Echo, Cabin John, Marshall Hall, Md.; Cherrydale, Rosslyn, Va.; Monongalia, Wood, Hancock, Harrison, Upshur, Tyler, Preston, and Tucker counties, Morgantown, Kanawha, Clarksburg, W. Va.; southern Ohio, particularly Brown, Clermont, and Hamilton counties; Nazareth, Frankfort, Ky.; Cadet, Louisiana, Mo.; Indianapolis, Ind. (Blatchley).

INJURIOUS OCCURRENCES IN 1898.

Frequent inquiry has been made concerning this species and the injury committed by it, but it will be sufficient for present purposes merely to recount the occurrences of the year 1898 as an example of what is liable to happen any year.

May 10 beetles were observed in a raspberry patch at Tennallytown, D. C., feeding upon the upper surface of the leaves. July 1 we received a communication from Sister Marie, Nazareth, Ky., about injury to locust in that locality. July 22 Maj. Henry E. Alvord, of this Department, transmitted specimens of locust leaves from Fairfax County, Va., with accompanying statement that all locust trees over an area of several square miles in that county were at that time apparently dead, looking as if a fire had swept through the country, but without actually consuming the foliage. Major Alvord was interested to the extent of 300 acres, carrying a very large locust growth of considerable value. On this tract not a tree could be found, either old or young, protected or exposed, that was not in bad condition. The cause of the affection of the plants was not at first attributed to insects, but believed to have developed as a result of a recent period of exceptional dryness and heat, a remark which applies to much injury to locust that is caused by this leaf-miner. Ravages were so extensive, also, that it was practically out of the question to attempt any general remedy or means of prevention. August 1 we received from Mr. J. E. Herbert, York, Pa., specimens of leaves showing injury by this species and attributed to blight or rust. Injury was stated to be general along the Susquehanna River, in York County, where every locust tree seemed to be affected.

HISTORY AND LITERATURE OF THE SPECIES.

The natural history of the leaf-mining locust beetle was first made public in an article "Upon the Economy of Some American Species of *Hispa*," by Dr. Harris, printed in 1835 (Boston Journ. Nat. Hist., Vol. I, pp. 141-151), an account which, until comparatively recent years, constituted the only source of information regarding the early stages of the *Hispini*. It is noticeable that neither Harris nor subsequent authors of early times mentioned this species as particularly troublesome, the first instance of observed injury having been published in 1868 in an editorial answer to a correspondent of the *American Entomologist* (Vol. I, p. 58). The injury in question was at Frankfort, Ky., and it was stated that the beetles had eaten the leaves of black locust in that section so severely as to kill the trees in some cases, and generally to injure their growth and appearance. It was pointed out in the editorial reply that the principal damage was doubtless due to the insidious work of the larvæ in the pulpy internal sub-

stance of the leaf, rather than to the feeding of the beetles on the leaves.

The nature of the damage effected by this insect is well illustrated in an article which appeared in Volume III of the American Entomologist (pp. 59-61) by V. T. Chambers. Injury by this species is stated to have been rather general in northern Kentucky. "By the 1st of August the groves look as if a fire had swept over them; and on examining the leaves in many groves almost every leaflet will be found to contain a 'mine,' as the burrow of the larva is technically called, and many of them will contain three or four, while the imago or mature insect of *Hispa saturalis* will be found in great numbers feeding externally on the leaves."

About half of the injury was attributed to the leaf-mining locust beetle, the remainder to other species of leaf-miners.

The bibliography of this species has been brought together up to 1896 in Dr. Lintner's Twelfth Report on the Insects of the State of New York for that year (pp. 264, 265), and the subject need not be entered into here in detail. It should be mentioned, however, that the ravages of this species had assumed sufficient proportions in West Virginia to call for special investigations on the part of Dr. A. D. Hopkins, these studies having been begun in 1890, the results being published in a short article in Bulletin No. 16 (p. 87). In the Canadian Entomologist for 1896 (p. 248) the same writer mentions the destructiveness of this species in West Virginia, adding some new food plants, and in Bulletin No. 9, n. s. (p. 20), the junior author called attention for the first time to the fact that this species fed also upon herbaceous plants, and that the larvæ develop in the leaves of soy bean. Other accounts, which appeared with and since the year 1896, contain little more than mention by State entomologists of ravages made by this insect in their respective States, all of which have been briefly brought together in the introductory chapter on this species. Exceptions are Dr. Lintner's article previously cited and a column article by Prof. E. D. Sanderson on page 672 of American Gardening for September 30, 1899.

FOOD PLANTS.

This species forms a rather interesting example of an insect with a well-known favorite food plant, which will also feed, even in times when this plant is available, on numerous other forms of vegetation, both related and otherwise.

The prime, and no doubt the original, food of the larva and beetle is, of course, common locust (*Robinia pseudacacia*), but there is no doubt that larvæ could develop equally well in the leaves of other species of the same genus, and perhaps of most other trees of the same family. On the grounds of the Department of Agriculture at Washington the

insect has been found in about equal abundance on various cultivated varieties of this locust, and the larva has also been observed in the leaves of false indigo (*Amorpha fruticosa*). Beetles are not infrequently met with upon various other trees, and more especially oak, but the larva has not been found until recently on any other plants than the two above specified. In the year 1880 this species was stated by Dr. John H. Warder (American Ent., Vol. III, p. 151) to be devouring the foliage of Siberian crab apples, and rendering it quite shabby, other forms of apple of the immediate vicinity escaping attack. The *Crataegus tomentosa* and some quinces appeared eroded in the same manner, and, although the insect was not seen, the injury was probably due to this species. The same correspondent mentions the young leaves of red oak (*Quercus rubra*) and European white oak (*Q. pedunculata*) as having been attacked, while nine or ten other species of oak observed escaped injury. It seems probable that the larva does not develop in oak, or in other plants outside the order to which the locust belongs, the Leguminosæ. The leaves of *Ulmus americana*, or white elm, were also stated by Dr. Warder to have been eaten.^a The beetles have been observed by Dr. Hopkins (Bul. 32, W. Va. Agric. Ex. Sta., 1893, p. 202) attacking beech, apple, wild cherry, and Wistaria leaves; as also birch and hawthorn (Can. Ent., Vol. XXVIII, p. 248). During the summer of 1897 the writer observed this species feeding upon the foliage of red clover, which grew under locust trees upon which the larvæ had originally fed, on the leaves of hog peanut (*Eulecanta comosa*) growing under locust trees, while larvæ were found and reared on the large hairy leaves of soy beans on the grounds of this Department about 200 yards from where locust trees were growing (Bul. 9, n. s., Div. Entom., pp. 22, 23).

LIFE HISTORY AND HABITS.

The beetle. -In the vicinity of Washington the beetle makes its first appearance as soon as the leaves of the locust tree have fully developed, usually about the beginning of May, and is then to be seen without interruption throughout the summer, until the first half of September,^b being quite abundant from the first week of July to near the middle of August. During 1902 the beetles of the first new generation began to develop July 7 and had transformed for the most part by the 12th of that month.

The beetle is usually seen, apparently motionless, upon the surface of the leaves, but upon close inspection it will be found busily engaged

^aOwing to the confusion in the scientific nomenclature of our locust Hispid, these other records are not quite reliable, and may refer either to *Odontota rubra* or to *O. nervosa*, as these species are now known.

^b Dr. Hopkins has recorded the occurrence of *O. dorsalis* in West Virginia as late as October 3, but does not state if the beetles were feeding at this time.

in feeding. Early in the season, when the leaves are still tender, the beetle eats small oblong holes in the leaves, but later in the season it usually leaves the lower half intact and the upper portion finely skeletonized. At any rate, the damage done by the beetles, even when they are very numerous, is trifling when compared with that inflicted by the larva. The beetle is a slow walker and apparently dislikes to move about without cogent reason, but if disturbed it takes wing rapidly and is capable of sustained flight for long distances. During rainy weather, at night time, and during the act of oviposition the beetle is to be met with on the underside of the leaves.

Hibernation.—There can be no doubt that the perfect beetle alone hibernates. It seeks winter quarters rather early in the season, some time in September. During mild winter days a specimen may occasionally be found under accumulated leaves at or near the base of locust trees, but even for an experienced entomologist it is not an easy task to find them in their sheltered retreats.

Mode of oviposition.—Dr. Harris's description of the eggs of *Hispani* (Treatise, etc., Flint ed., p. 120) does not apply to this locust beetle, and appears to have been made from dried cabinet specimens. The fact is that in our species the eggs are not laid on the upper side of the leaf but always on the underside, and, further, that they are not laid singly but in masses, each composed of from three to five eggs, which are glued together by a sticky substance and partially covered with an excrementitious secretion. We succeeded in July in partially observing the act of oviposition, which may be described as follows: One egg was already deposited, representing a somewhat flattened, short, oval object of yellowish-pink color fastened to the leaf by its flat side. The female beetle was quietly resting with the forepart of her body much erected and the last abdominal joints covering the egg, while the tip of the elytra touched the surface of the leaf beyond the egg. After a while the tip of the abdomen was bent toward the egg and a yellowish-pink semifluid matter was excreted; then an egg appeared at the genital opening, but was several times retracted and again protruded, when finally, with a sudden effort, the beetle moved its abdomen a little backward and deposited the egg so that with its end it rested upon the leaf and with its greater portion over the first egg. Then the beetle rested for about two minutes, when the same process was repeated. The act of oviposition itself takes only a fraction of a second. When the last egg has been laid the beetle makes a sudden movement forward, sweeping with the tip of the abdomen the upper side of the egg mass and discharging at the same time a large quantity of fluid fecal matter of dirty-yellow color, which soon hardens and darkens.

From this mode of oviposition the form of an egg mass can be readily understood. Since the second and the following eggs each overlap the preceding egg, but at the same time touch with one end the surface

of the leaf, it is evident that each egg is placed somewhat more vertically than the preceding one. But as there are never more than five eggs in a single egg mass, the last of these is still placed obliquely, and the egg mass when viewed from the side slopes very gradually in the direction toward the first egg while it ends more abruptly at the last one. Owing to the glutinous and excremental coverings the individual eggs can not be distinguished from above, but on the sides and from beneath, where the glutinous covering is very thin or absent, they may be plainly distinguished. The glutinous substance appears to possess some caustic properties, for the place of an egg mass can always be seen on the upper side of the leaf as a small brown spot. It hardens very rapidly, and becomes so tough and firmly adherent to the eggs that these can not be taken out from a mass without destroying them.

The duration of the egg state appears to be very variable, most of those which were gathered (in July) when apparently quite freshly laid hatching in from six to eight days, while others of the same batch hatched nearly a week later, but in every instance all the eggs of one egg mass hatch nearly at the same time, or at least within the space of a few hours, the first-laid egg usually hatching first.

The larva and its work.—The young larvæ invariably break through the egg shell on the underside of the egg mass and at once begin to gnaw through the epidermis of the leaf without leaving the protecting egg mass. Then they proceed to eat out the inside of the leaf, leaving only the epidermis of both sides of the leaf intact, thus forming what in scientific terminology is known as a tentiform mine. There is only one entrance to the mine, that made by the first-hatched larva, the other larvæ entering the inside of the leaf by the same hole. Thus from three to five young larvæ are usually found within the same mine, which rapidly grows through their united efforts. In fact, within a few hours four young larvæ had hollowed out about one-fourth of a large leaf, and it is evident that a single leaf is not sufficient to nourish the larvæ during their life duration. Moreover, the larvæ have the habit of hollowing out not more than one-half or at most two-thirds of a leaf. Thus in from two to four days after hatching (the time varying according to the state of the weather, the number of the larvæ, and the size of the leaf) the larvæ leave their original mine, wander off along the leaf stems, often to a considerable distance and to another twig, and form new mines, but this time each larva lives by itself. There are never two separate mines on one and the same leaf, and only once were two nearly full-grown larvæ found in the same mine. In captivity this process of migration was repeated as often as the leaves began to wilt, but we did not succeed in ascertaining the number of these changes in nature, owing to the difficulty in following the individual larvæ in their migrations, which appear to take place at night. This much has been ascertained, that at least

some larvæ change their habitation three times, but whether all larvæ have the same habit, or whether they change oftener than three times, is uncertain. However that may be, it will be seen that the damage inflicted by the larvæ is greatly increased by these migrations, for every leaf attacked is doomed to destruction.

The duration of the larva state appears to be quite variable. In captivity no larva was actually carried through from the time of hatching to pupation, but from observations in the field it is pretty clear that this period, even in the height of the season, is never less than two weeks, and probably lasts on the average three weeks, being somewhat longer in the beginning of the season than in midsummer.

The pupa.—The pupa state is assumed within the mine and lasts from six and a half to ten days, after which the perfect beetle breaks its way through the brittle epidermis of the leaf.

At 11 a. m. of August 5 a larva taken from its mine was found to have transformed to pupa within two or three minutes, the change having taken place while it was being taken from one room to another and returned. August 12 the imago was found fully colored early in the morning, the pupal period having been passed in about six and a half days. Temperature, 75°–80° F.

The number of generations annually.—This is a point in the natural history of the insect which has not hitherto been clearly made out. Dr. Harris (Ins. Inj. to Veg., Flint ed., p. 121) is evidently in favor of a single generation, and we have no doubt that this will hold true for the more northern States; perhaps elsewhere. In the latitude of Washington the insect, as has been stated, appears in May, one month earlier than in Massachusetts, and is then to be found in all stages throughout the summer, until the beginning of August, when egg laying ceases. It is therefore evident that individuals produced from eggs deposited early in the season developed to the mature insect early enough to produce a second generation in the same manner, but no second generation has as yet been segregated.

NATURAL ENEMIES.

Of nonparasitic enemies we have observed at Washington the wheel bug (*Pyrisoides cristatus*), which appears to be particularly attracted by the presence of the *Odontota*.^a The young larvæ of the wheel bug may frequently be observed slowly walking over the leaves until they have found a mine inhabited by the *Odontota*. This found, the wheel bug deliberately pierces with its beak the *Odontota* larva through the

^aThe abundance of the wheel bug on the Agricultural grounds on the trees infested by the *Odontota* is in striking contrast to its comparative scarcity on the elm trees infested with the imported elm leaf-beetle (*Galerucella latulæ*) and which are in close proximity to the locust trees.

epidermis of the leaf. Should a beetle be met by the wheel bug it is at once lifted in the air on the tip of the bug's proboscis.

In its earlier stages the leaf-mining locust beetle appears to be well protected from the attacks of true parasites, the eggs being inclosed in an armor-like covering, and the pupa remaining out of sight in the snug retreat of the mine, but still we have reared in a single season no less than four different species of parasites, and Dr. Harris mentions and describes still another species (*Ichneumon hispie*) which has thus far remained unknown to us. These four species of parasites are as follows:

Trichogramma odontotæ How.—Was reared quite commonly from the egg masses of this beetle. In cases of parasitism all the eggs of an egg mass were generally parasitized, and only in a few instances were two or three parasitized eggs found where the rest produced larvæ. The fly emerges usually from the underside of the egg and gnaws its way through the leaf. Dr. Howard described this and the other three species which will be mentioned below, in Volume I of *Entomologia Americana* (pp. 117-118).

Derostenus primus How.—A few specimens of this chalcis fly were obtained from the egg masses of the *Odontota*. The breeding of one of these species from the peculiar pupæ of a *Eulophus* would seem to indicate that it may in all cases be a secondary parasite, and that the specimens bred from the egg of the *Odontota* may have fed in the larva state upon the larvæ or pupæ of *Trichogramma odontotæ*.

Sympiezus uroplata How.—Upon opening the mines we observed in a few instances a whitish hymenopterous larva feeding externally on the *Odontota* larva and having already devoured the posterior half of its body. The host larva was of course dead when thus found. Whether or not this parasite in its earlier stage lives within the *Odontota* larva has not been ascertained. It appears to be very rare, and of the three specimens observed only one was raised to the perfect insect. It formed a naked black pupa within the mine.

Spilochalcis odontotæ How.—This parasite was observed emerging from the *Odontota* pupa, and no doubt lives as larva within that of the *Odontota*. The parasitized pupæ can be distinguished from the healthy ones by being darker and rigid. Upon opening such pupæ the parasite larva, apparently full-grown, was found to occupy the empty cavity, but the specimens thus disturbed died without changing to pupa. Only one winged parasite was obtained from a pupa which was left undisturbed in the mine.

The *Ichneumon hispie* described by Harris was obtained by him from the pupa of *Odontota quadrata* (= *rosea*) and *O. scutellaris* (= *dorsalis*). It may belong to the Braconide. Harris's description was published in 1835 (*Boston Journ. Nat. Hist.*, Vol. I, p. 150).

REMEDIES.

From what has been said in regard to the feeding habits of the leaf-mining locust beetle it is obvious that whatever of a remedial nature is employed must be directed toward the beetles, since the larvæ are completely hidden in their mines in the leaves during their short lifetime, and the eggs and pupæ are similarly protected from contact poisons. The beetles can be killed by means of the arsenicals

administered in the form of a spray^a in the same manner as for the imported elm leaf-beetle.

The leaves of locusts are so smooth that they are apt to shed an ordinary spray of Paris green, but this can be obviated by the addition of glucose or molasses to the spraying mixture, or by the more adhesive arsenate of lead. It should be unnecessary to state that the proper time to spray is upon the first appearance of the beetles in May or June, according to the localities infested, that the beetles may be destroyed before egg-laying commences.

Small groves can be protected by jarring the beetles from the trees into sheets prepared for the purpose and saturated with kerosene in the same manner as in use against the plum curculio and other beetles which drop to the ground and feign death when disturbed. The best time for this remedy is in the early morning, while the beetles are still somewhat sluggish. This method could only be employed with benefit before the beetles have oviposited, and with the coöperation of neighbors who possess similar trees, or in localities where the locust trees are isolated, not surrounded by others growing wild. This manner of collecting the beetles, to be effective, would have to be practiced every few days so long as the beetles continue to be attracted to the trees.

Where only a few trees in yards or lawns are to be protected, even more simple mechanical methods could be employed, such as jarring the beetles into inverted umbrellas and picking off the egg masses before these hatch. The egg masses are not difficult of detection and are sufficiently conspicuous by reason of their size and color to be easily seen by looking for them from beneath the branches toward the light.

In connection with any remedy that might be employed, clean culture must always be practiced, which includes the destruction of all volunteer locust growth in the immediate vicinity of trees planted for shade and ornament, and the prompt raking up and destruction of the locust leaves and other débris about the trees in the early autumn.

The protection of extensive woody tracts in which locust predominates is practically out of the question.

THE LEAF-MINING LINDEN BEETLE.

(*Odontota rubra* Web.)

This is also one of the species observed by Harris. He states that he discovered the larvæ in 1827 and afterwards feeding upon a

^a Instructions for the application of the arsenical poisons against the latter species are given on pages 3 and 4 of Circular No. 8 of this Division, as also on pages 10-12 of Farmers' Bulletin No. 99, and as both of these publications can readily be obtained by application to this Department, no further instructions need be given here.

parenchyma of a leaf of white oak. A description of the larva is given, with biologic notes (l. c.). Since that time this species (fig. 4) has been found to attack numerous other plants, and the writer has already expressed the opinion that the foliage of linden, or basswood (*Tilia americana*), is the favorite food tree. Larvæ and adults, the former mining the leaves and the latter feeding on the lower surface of the same, can be found in abundance at Ithaca and elsewhere in New York during the month of June, the imago occurring as late as September (Proc. Ent. Soc., Wash., Vol. II, pp. 266, 267).

Among other food plants are English filbert and orange, the imago having been found occasionally attacking the leaves of the last mentioned plant in Florida by the late H. G. Hubbard. It is more particularly, however, as an enemy to apple that this species has received mention by Harris (Ins. Inj. to Veg., 1863 ed., pp. 120, 121). Chokecherry (*Prunus virginiana*) is also recorded as the food plant by Harris, as also the shadbush or service berry (*Amelanchier canadensis*).

It has been called the rosy Hispa, from one of the Latin names (*Hispa rosea* Web.).

According to published statements the beetle makes its appearance during the latter part of May, and soon afterwards deposits its eggs on the leaves of the trees which form its larval food plants. The eggs are described as small, round, and of a blackish color, fastened to the surface of the leaf either singly or in groups of four or five.

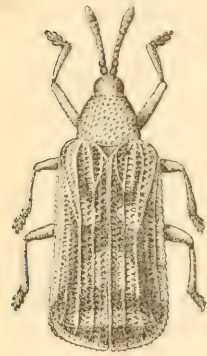


FIG. 4.—*Odontota rubra*: beetle, about seven times enlarged (original).

In most respects the life history of this insect appears to resemble very closely that of the leaf-mining locust beetle. Fortunately it seldom occurs in abundance and has not often been reported, to the writer's knowledge, as having been the source of any considerable trouble. The experience of Mr. W. L. Devereaux at Clyde, N. Y., cited in the Fifth Report of the United States Entomological Commission (p. 480), that this insect is a very conspicuous pest in that vicinity, "destroying the entire foliage of every basswood in many forests except trees of great height," appears to be unique.

Concerning this species Mr. William Beutenmuller writes in 1890 that it "mines the leaves of apple and linden." The perfect insect may also be found on white birch, hornbeam, cherry, Juneberry (*Amelanchier*), and *Pyrus arbutifolia* (Entom. Amer., Vol. VI, p. 178).

ODONTOTA NERVOSA Panz.

This common little species, which has also received rather frequent mention under its two synonyms, *inequalis* Web. and *rosea* Web., is

mentioned by Chambers (Canadian Ent., Vol. IV, 1872, p. 125) as mining the leaves of *Eupatorium ageratoïdes*, one of the bonesets.^a During the season of 1890 it was stated by Dr. Hopkins (Bul. 16 W. Va. Agric. Ex. Sta., p. 88) to be "found quite plentifully with the locust Hispa feeding upon the surface of the leaf [of locust]," while in Bulletin No. 32 of the same station (p. 202), the same writer states that this species is "very common on yellow locust leaves; also feeds on apple leaves," recording capture of the adults from April 30 to July 16 in Monongalia, Wood, Hancock, and Jackson counties. During 1902 the writer also observed it on locust in Maryland, and reared the beetles from mines in the leaves. There is also a Divisional record of the rearing of this leaf-beetle on a species of aster in the District of Columbia, July 29. September 1, 1899, Mr. Th. Pergande reared it also from *Cassia nictitans*.

A pale variety or race was found by Messrs. Hubbard & Schwarz feeding in great abundance on the leaves of *Robinia mammosicarpa* in the Santa Rita Mountains of southern Arizona during the months of May and June, but no trace of either eggs or larvæ could be seen on this plant.

ODONTOTA BICOLOR *Ol.*

This species is not rare in the District of Columbia and vicinity, but the writer has frequently sought for its mines on various wild plants without success. It remained for Mr. Th. Pergande to ascertain its true habits. The larva mines the leaves of grasses, Mr. Pergande having found it in the leaves of *Panicum macrocarpon* from June 18 to 26, 1899, at Cabin John Bridge, Md. The first beetle issued July 1. The beetles have been collected by the writer in greatest number during the second and third weeks of June.

ODONTOTA HORNI *Sm.*

Mr. H. W. Wenzel has found this species on *Cracca* [*Tephrosia*] *virginiana*, a papilionaceous plant commonly known as goat's-rue, at Da Costa, Atlantic County, N. J. (Ent. News, Vol. V, p. 41). It has been found also near Washington, D. C., on the same plant.

ODONTOTA NOTATA *Ol.*

This species was also taken by Mr. Wenzel on *Tephrosia virginiana* with *O. horni* previously mentioned.

It is common near Washington, D. C., in Virginia, and the peninsula of Florida in localities where *Tephrosia* is absent. Mr. Schwarz thinks that the food plant will prove to be a species of *Solidago*.

^aMr. Beutenmüller (Ent. Am. VI, 1890, p. 178) states that he reared this species from *Eupatorium* and asters.

ODONTOTA CALIFORNICA *Horn.*

The larval food plant of this species, *Ceanothus integerrimus*, has been placed on record in Volume V of Insect Life (p. 269) from rearings made by Mr. Coquillett while agent for this office in California. He found it mining the leaves of this plant, and reared the adult in September.

A Chalcidid was also reared from the larvæ of this species.

ODONTOTA SCAPULARIS *Ol.*

Nothing appears to be recorded of the food habits of this species further than it was captured on a species of hazel (*Corylus*) in Kansas (E. A. Popenoe, Trans. Kan. Acad. Science, Vol. V, 1877, p. 36). The beetle has also been taken on *Solidago* in and about the District of Columbia, but the larvæ have apparently not yet been identified.

MICRORHOPALA VITTATA *Fab.*

This is one of the common species which are to be found northward, and was observed by Harris in 1833 on the leaves of *Solidago* "*lavigata*" = *sempervirens* or seaside golden-rod. The account in question includes a description and figure of the larva, as also the mature beetle. What were presumed to be the eggs were also described.

The larva, which has been observed on other species of *Solidago*, including *lanceolata* and *canadensis*, forms blister-like mines in the leaves much like those of other species of the same group. This insect appears to be most abundant upon plants growing near the seashore and along the river banks, and is quite abundant along the coast of Massachusetts, Long Island, and New Jersey. It is common, but not nearly so abundant along the Potomac River and its branches in and near the city of Washington.

The eggs have been found near the tips of the leaves on the lower surface. They were covered with a brown substance evidently excremental, and mixed with the hairs of the leaf.

A female was noticed which had just deposited two eggs, May 13, at Rosslyn, Va. She was at this time quietly resting, head downward with the tip of her abdomen just touching the eggs.

This species has also been found parasitized by a Chalcidid.

MICRORHOPALA XERENE *Newm.*

This attractive little species occurs in considerable abundance in the vicinity of the District of Columbia and has been given some study by the author. It appears to have a somewhat greater diversity of food habits than the innoxious species which have been previously con-

sidered, this being especially true of the larva which has been found mining the leaves of several genera of Compositæ, although different species of golden-rod appear to constitute its principal food. The plants upon which the larvæ have been observed to make their mines and from which the beetles have been reared include: *Solidago canadensis*, *cæsia*, *juncæ*, et al.; *Boltonia asteroides*; *Sericocarpus asteroides*, or toothed white-topped aster, and several species of the true aster, or starwort. So far as observed, this species has confined its attacks to wild plants, but as the *Boltonia* mentioned and many asters are cultivated it will probably be found to attack some of these in time.

The beetles eat out little elliptical holes in the leaves of their food plants after the manner of the commoner *M. vittata*. Frequently three or four beetles have been observed crowded closely together upon a single leaf of golden-rod. In such cases they sometimes nearly strip the leaf attacked. What is true of the beetle is equally true of the larvæ. Unlike the locust-mining species, as many as four larvæ can develop in a single large leaf. June 24, four pupæ of normal size were found together in a leaf of *Solidago cæsia*, the mine occupying about three-fourths of the apical end of the leaf.

It would be a difficult matter to describe the mines accurately, as these are so variable and, as previously stated, sometimes occupy a very considerable portion of a leaf. The mine, at the point where the pupal cell is formed, puffs up so as to form a hard blister, more or less rounded oval in shape, usually a little over an eighth of an inch wide, which sometimes becomes as thick through, its dimensions being dependent upon the number of individuals which inhabit it.

The eggs, as might readily be inferred from the smaller size of this beetle, are not so large as those of other species which have been described. They are very closely appressed to the surface of the leaf on which they are deposited and are covered with dark, nearly black, excrement, sometimes all the eggs of a group which are placed closely together being covered with a common coating. The eggs are usually deposited on the lower side of a leaf, but in one instance a batch of five eggs were found on the upper surface. Most frequently they are placed near the edge, sometimes midway between the tip and the base of a leaf, but generally above the middle.

The larvæ possess the same power as do those of the locust-inhabiting species of passing from one leaf to another, and larvæ in confinement have been seen in the daytime crawling out of a leaf and re-entering in a fresh place. Larvæ have been noticed to forsake their mines when the leaves were not in a condition that was entirely to their liking. Such desertion of mines was observed on one occasion. June 16, all of the larvæ transforming to pupæ, and, in due time, to adults, the first imago appearing June 24.

The pupal condition was observed in three individuals during the last week of June, in hot weather, and lasted four and a half, five, and five and a half days, respectively. From finding several pupal cells as early as June 10, it was evident that the first of the new brood, or generation, of beetles begins to appear at least as early as that date.

The larvæ and pupæ resemble in a general way those of the preceding species and no detailed descriptions have been made. The larva when full grown measures from 6 to 6.5^{mm} and the pupa about 5.5^{mm}. It was noticed that the pupæ moved by elevating the abdominal segments and bringing forward the last segment, thus giving a forward impetus. The pupæ moved slowly, however, at the rate of about 1.5^{mm} at each step (if this expression can be used to describe the motion) which is as fast or faster than the pace of the larvæ. Pupæ were noticed to make as many as twenty consecutive movements.

No less than four distinct parasites have been reared from this leaf-miner about the District of Columbia. All are Chalcididæ, and the list is as follows:

Eurytoma albitarsis Ashm., from mines in *Solidago*.

Closterocerus tricinctus Ashm., from a mine in *Sericocarpus asteroides*.

Tetrastichus microrhopalæ Ashm.—A large series was raised from the dried larval skins, July 7–14.

Mesocrina microrhopalæ Ashm.—A single example reared July 6 from a white cocoon in a mine of this beetle.

A single example of the beautiful little *Hippoccephalus multivinctus* also issued from mined leaves, but may possibly have bred from some species of Tineidæ as this Chalcidid is known to live parasitically on this order of insects and has not been observed to attack Coleoptera.

MICRORHOPALA MELSHEIMERI Cr.

Mr. Henry Ulke found a specimen of this beetle in an ant's nest at Pen Mar, Pa., but it is probable that this was an accidental capture. (Proc. Ent. Soc. Wash., Vol. I, 1890, p. 248.)

MICRORHOPALA FLORIDANA Schwarz.

This species was reared by Messrs. Hubbard and Schwarz at Crescent City and Bartow Junction, Fla., from larvæ found mining in the terminal portion of the leaves of grass-leaved golden aster (*Chrysopsis graminifolia*).

OCTOTOMA PLICATULA Fab.

The Virginia creeper, *Tecoma radicans*, has been known as the food plant of this species (fig. 5) since about 1879, but was not placed on record until 1890, when a short note was published in the Proceedings of the Entomological Society of Washington (Vol. I, p. 232). The larva makes a tentiform mine in the leaves of this plant, and the imago eats

oblong holes in the leaves. It is somewhat remarkable that the food habits of this species had been overlooked, as far as published records go, until that time, considering that the insect is widely distributed and frequently found in large numbers. The plant has a still wider distribution than the beetle, which is proved by failure to find it upon this plant in Michigan and in central and southern Florida, as well as in other localities. Even in the vicinity of the District of Columbia the species is local and not to be found wherever its food plant occurs.

May 25, 1879, the habits of this species were first observed by Mr. Schwarz at Columbus, Tex. It was noticed that a pupa was always to be found in a pocket adjoining the midrib. The beetle feeds also on the plant. The mines consist of several sinuous branches starting from the midrib, these branches being of varying length and shape. At the end toward the base of the leaf there is usually an oblong, or nearly oblong, blackish spot, presumably where the egg has been deposited and where the excrements of the larvæ collect.



FIG. 5.—*Octotoma plicatula*: beetle—about seven times natural size (original).

OCTOTOMA MARGINICOLLIS Horn.

The perfect beetles were found by Messrs. Hubbard and Schwarz in great numbers riddling the entire foliage of certain small ash trees in Madera Canyon, Sta. Rita Mountains, in southern Arizona, during the months of May and June. Neither eggs, larvæ, nor larval mines were seen on the trees at this season, and it would seem that the real food plant of the species is a vine or some other plant which makes its appearance only after the beginning of the rainy season toward the end of July or in August.

STENOPODIUS FLAVIDUS Horn.

From various structural details of this genus, Dr. Horn suspected that the habits of the only species would prove to be subaquatic. While nothing definite has been ascertained regarding the larval habits, the imago has been found in various localities remote from any water, and under conditions which strongly suggest the larval food plant. Near Brownsville, Tex., Mr. Townsend and Mr. Schwarz found a number of specimens on a malvaceous plant which appears to belong to the genus *Abutilon*.

GENERAL NOTES.

ERRONEOUS BELIEF THAT COMMON NATIVE INSECTS ARE INTRODUCED FROM ABROAD IN SEED.

Every month or two during the warm season we receive communications from farmers in various portions of the country, more particularly in the more sparsely settled States where new crops are being cultivated, concerning the probable introduction from abroad of many common species of insects in seed furnished by the United States Department of Agriculture and experiment stations. Such a communication was received from a correspondent in Texas who had never seen the Colorado potato beetle there before, although the insect has been present in that State since about 1882, and probably earlier, with the remark that it was supposed to have been introduced with seed potatoes from Minnesota. May 27, 1902, another correspondent at Gainesville, Cook County, Tex., wrote in regard to the striped cucumber beetle, which he believed had been introduced with seed received from this Department. In response to inquiry as to particulars, he wrote, that although for twenty-five years he had had experience each year with nearly all the vegetables named in circular No. 31 as food plants of this beetle, he had never seen the insect before, and thinks it impossible for it to have been present on his plants without his having noticed it. Neither had any of his neighbors taken notice of this insect. It seems to have first appeared there in destructive numbers in 1902.

CAPTURE AND POSSIBLE INTRODUCTION OF THE NUN MOTH IN AMERICA.

On the occasion of a visit to Washington by Dr. W. J. Holland, a well-known authority on Lepidoptera, he mentioned the fact that the nun moth (*Psilura monacha* Linn.)^a had been obtained from a collector in the vicinity of Brooklyn, N. Y. Mr. George Franck, an experienced collector of that city, was referred to as authority, and in answer to an inquiry for the particulars of the capture of this insect, he wrote substantially as follows: In looking over a small collection of a local collector during the summer of 1901, he found, among other material, five individuals of this species, identified by comparison with European specimens of which he possessed a number. The collector in question had no communication with others than Mr. Franck, from whom he obtained material in exchange. He was questioned regarding this species and its occurrence, and Mr. Franck was assured that the specimens had been captured at light in Brooklyn. No other person who had been consulted in regard to this species knew anything of its occur-

^aAlso frequently mentioned in literature as *Liparis monacha*, and recently placed by Meyrick in the same genus as the gypsy moth, *Ocneria*.

rence in that vicinity, and it was put down as an accidental importation, which is probably the truth. The collector resides in a district where there are numerous lumber yards, and shipping is carried on to a great extent. The exact location is described as being around North Second street and Metropolitan avenue, near a creek which adjoins that portion of the bay running through the eastern part of Brooklyn.

As only five of the insects were captured it does not necessarily imply that the species has been introduced, but we may have here a parallel case to that of the gypsy moth, which was known to have been actually introduced in this country twenty-five years before it attracted the attention of economic entomologists. As the two species are related and have similar habits, there is reason to believe that if the nun moth does become permanently located in the vicinity of New York, it will prove a national calamity, and more troublesome even than the gypsy moth, as it will be difficult to deal with the pest in such a locality. The gypsy moth is established inland, while the nun moth, if it has obtained permanent foothold (which may not be ascertained for a number of years), will probably have spread to the immediate vicinity of waterways on either side. It is a matter that should be made public at once, that all persons interested in entomology and in agriculture may be warned to keep a sharp lookout for this species during the coming years. The Division of Entomology should be notified of captures of anything suspicious, and any insect suspected of being the nun moth should accompany the letters.

ESTIMATED LOSS OCCASIONED BY THE VARIEGATED CUTWORM IN 1900.

In looking over accounts of injuries recently occasioned by various well-known species of noxious insects, the writer noticed the lack of reliable estimates of money losses sustained. The question of the extent of the damage due to the ravages of the variegated cutworm (*Peridroma saucia*) in 1900 was entirely lost sight of, by the writer as well as by others who published in regard to injuries.

Occasion was therefore taken, in writing Dr. James Fletcher, Dominion entomologist of Canada, to make inquiry in regard to injuries in the Dominion. Through him we obtained information from Mr. J. R. Anderson, deputy minister of agriculture for the province of British Columbia, as follows: "Replying to Mr. Chittenden's inquiry as to the loss from the variegated cutworm last year—from all the information obtainable and making an addition for unreported districts, the losses foot up to \$168,000."

Next, Prof. C. V. Piper was written to in regard to damage inflicted by this cutworm in the State of Washington, and he obtained from Mr. David A. Brodie an estimate of \$1,012,500 in western Washington, this being based upon the estimate of damage in British Columbia. In commenting on this, Professor Piper stated that he could well believe

the loss in Washington to be ten times as great as that in British Columbia, that is, \$1,680,000.

In Oregon, Prof. A. B. Cordley, entomologist of the experiment station at Corvallis, placed injuries at the modest estimate of \$50,000.

If to the estimated damage in British Columbia we add the injury which was accomplished in the Provinces of Ontario and Manitoba, there will be no difficulty in raising the figures for the Dominion to \$200,000. Then it must be remembered that isolated instances of injury were also reported in various States, for instance, in California, Texas, Missouri, Kansas, West Virginia, Illinois, Maryland, Virginia, and the District of Columbia. Taking all data into consideration, accounting for many localities from which no reports were received, admitting that this species was undoubtedly responsible for much injury merely attributed to cutworms in general and not reported to any official entomologist, also that it is cosmopolitan and practically omnivorous, it would seem that an estimate of \$2,500,000 would not be too high as the total cash value of crops injured in the United States during the single season of 1900.—F. H. C.

OCCURRENCE OF THE MEDITERRANEAN FLOUR MOTH IN MINNESOTA, WISCONSIN, AND MICHIGAN.

During the past two years several complaints have been made to this office of trouble occasioned by the presence of the Mediterranean flour moth (*Ephestia kuehniella* Zell.) in flouring establishments and warehouses in Milwaukee, Wis.; in Minneapolis, and neighboring cities in Minnesota; and quite recently in Detroit, Mich. Through other sources of information we have knowledge of the insect spreading to neighboring States and being further disseminated in other States where it has already been established for some time; in fact, it is apparent that it is now only a matter of a few years when this insect will become permanently established in most portions of the Union where milling is an important industry. All communications were accompanied by specimens, usually with all stages of the insect in infested flour webbed up in the manner characteristic of this species.

February 23, 1901, Mr. George W. Peckham wrote of the injurious occurrence of the pest at Milwaukee, Wis., transmitting material received from a gentleman largely interested in flour mills in that vicinity who had experienced a great deal of trouble with it. April 20 Mr. Harry D. Cushman, Minneapolis, Minn., stated that although he was not aware that mills in that city were badly infested with this moth, he understood that some mills in Superior had to close because of infestation. The modern system of keeping the mills scrupulously clean, not permitting dust or dirt to accumulate, and the turning of the stock of grain and its products every few days had eliminated to a

great extent the trouble that had previously been experienced. Our correspondent believed that this statement would apply to the larger mills, at least, of his locality. November 20, a correspondent at Balls Ferry, Shasta County, Cal., reported this flour pest in that vicinity. This appears to be a new locality in California, although the species is rather more widely distributed there than in any other State of the Union.

January 28, 1902, the president of a flour company at San Francisco, Cal., wrote in regard to the Mediterranean flour moth in that city. In putting up breakfast cereals his firm had been seriously annoyed by the eggs and larvæ of the moth developing several weeks from the time of packing. He said that the food material in question could be exposed to a temperature of 212° F. or thereabouts without serious damage. June 30 a merchant miller, of Detroit, Mich., sent this species in flour from a mill in that city. He was anxious to obtain information in regard to the use of hydrocyanic-acid gas, as the insurance companies refused to grant permission for the use of bisulphid of carbon as a fumigant. Two years earlier it was reported that one mill in Detroit was infested by this insect, and it was surmised that the present invasion was due to the introduction of wheat or secondhand bags from the Northwest, with little doubt from Milwaukee and Minneapolis, where this species as just reported is now known to be present in great numbers. It is now said that nearly all the mills in those two cities are completely overrun with this pest.

THE ANGOUMOIS GRAIN MOTH IN 1901.

In spite of the employment of precautionary as well as remedial measures that have been generally used against the Angoumois grain moth (*Sitotroga cerealella* Zell.) in the more northern States in which it is found, it continues to be injurious year by year, and it seems to be as troublesome now as ever, if, indeed, not more so. The following notes are extracts from correspondence during the year 1901. In nearly every instance specimens of the insect accompanied the letters.

February 8 we received word from the Larrowe Milling Company, New York City, that this species was a general pest throughout New Jersey and eastern Pennsylvania.

On the 27th of the same month Mr. James R. Kirby, Smiths Grove, Ky., wrote that the farmers of that vicinity were seriously troubled by this species.

March 4 Mr. William J. Haverly, Los Angeles, Cal., complained of injury to the seeds of field corn.

September 28 Mr. Horace L. Dilworth reported this species as doing great damage to wheat in the neighborhood of Centerville, Del.

October 17 Mr. Walter Geist, Shawan, Md., who runs a thrashing

machine, stated that in some places in that vicinity grain was very badly infested.

November 13, 1901, Mr. C. S. Scofield, of the Bureau of Plant Industry, exhibited specimens of wheat badly infested by the Angoumois grain moth, received from Mr. Charles Dunwoody, Philadelphia, Pa., who stated that his firm had handled through its warehouse about 30,000 bushels of this year's crop which showed the work of this insect. It was noticed that the insect had been gradually working a little farther west each year. Early threshing had been the principal remedy employed. All varieties of winter wheat and rye appeared to be infested alike. The ravages of this insect had first been noticed about four or five years previous to the date of writing, and had been increasing from year to year since. Mr. Dunwoody stated that the greatest damage was at that time reported from the counties of Delaware, Chester, and Montgomery, in Pennsylvania; as well as in some sections of western New Jersey. Nearly two-thirds of the grain in the regions mentioned appeared to be infested, and it was estimated that the damage was about 20 per cent of the value of infested lots. Mr. Dunwoody asserted that field-threshed grain is seldom infested, but that nearly all grain which goes through the "sweat" in barns is more or less affected.

From Rev. J. F. Sheppard, Conshohocken, Pa., we received information, under date of November 29, that this insect was ravaging granaries in that vicinity.

December 19 Mr. Theodore C. Search, Philadelphia, Pa., reported that this species was very destructive to the wheat crop of Bucks County, Pa. In a badly infested sample from Chester County, Pa., he stated that the wheat weighed only 38 pounds to the bushel, and was worth for feeding purposes 60 cents per bushel of 60 pounds on our present market. This same variety of wheat, if sound and in good condition for milling purposes, would bring 78 cents. Later he wrote that one reason why the Angoumois grain moth is so destructive in certain portions of Pennsylvania is the fact that in the vicinity of Philadelphia the farmers *prefer to thresh their grain during the winter season at odd times.*

In one sample of wheat from Pennsylvania infested by this moth many specimens of a parasite occurred; in fact, in this lot the moths were almost completely killed off, only one breeding out in the course of three weeks, the parasites occurring in the proportion of something like 50 to 1. The parasite having a somewhat novel appearance, it was referred to Mr. W. H. Ashmead, of the National Museum, who states that it is undescribed. It is a species of *Catolaccus*.

RECENT INJURY BY THE CIGARETTE BEETLE.

More complaints were received of injury by the cigarette beetle (*Lasioderma serricornis* Fab.) during the seasons of 1901 and 1902 than

ever before in its history; judging by correspondence, this insect is rapidly widening its range, and unless radical measures are taken by the individuals whose products suffer from its attack, the insect will undoubtedly continue to increase and spread and will soon become a species of the highest economic importance. Complaints of injury were received from different firms, mostly tobaccoists, wholesale and retail, in New York City; Baltimore, Md.; District of Columbia; Danville, Va.; Cincinnati, Ohio; Detroit, Mich.; Porto Rico; and Kingston, Jamaica. The insect was the subject of considerable correspondence from the localities mentioned. In most cases destruction was to tobacco, but certain other products were affected.

During February we received complaint from one of Cincinnati's largest department stores of injury to cigarette tobacco. September 21 a manufacturer and importer of cigars in New York City complained of this species, stating that the beetles were in every can of tobacco received from a certain firm. They were eating through the wrappers of cigars. October 10 complaint was made of considerable injury by this insect to upholstered furniture in department stores at Detroit, Mich. The insects were stated to be infesting the very best furniture in one house. In the latter days of October Mr. Frank D. Gardner, agent in charge of the experiment station at Porto Rico, stated that cigar dealers in San Juan had considerable trouble in keeping their stock for any length of time on account of the cigarette beetle boring holes in the cigars and practically ruining them. November 13 a cigar dealer at Baltimore, Md., stated that his firm had lost about 700 of their best cigars through the attacks of this insect.

During July, 1901, complaint was made by a large wholesale and retail tobacco establishment in the city of Washington of injury by this beetle, and an opportunity was afforded for disinfecting the establishment infested by means of bisulphid of carbon. This work was undertaken by Mr. W. E. Hinds, temporary assistant in this Division. The results of these experiments, which were eminently satisfactory, were published in Bulletin No. 30, new series, (pp. 78-82). This led to a further study of carbon bisulphid as an insecticide and to the treatment of this topic in a general manner. The results of further study and investigation have found expression in Farmers' Bulletin 145, prepared by Mr. Hinds with the cooperation of Mr. E. E. Ewell, assistant chemist of this Department. The cigarette beetle was also found by Mr. J. Kotinsky, of this office, in a pharmacy at Washington, D. C., affecting American saffron.

January 23, 1902, complaint was received from a prominent cigar manufacturer of New York City of injuries by this insect. April 9 Mr. H. H. Cousins, island chemist, of Kingston, Jamaica, requested information on dealing with the cigarette beetle, which he stated threatened the tobacco trade of Jamaica.

In practically all of the instances of attack that have been mentioned letters of complaint were accompanied by specimens of the insects at work in tobacco or other products affected.

INJURIOUS OCCURRENCE OF AN EXOTIC DERMESTID IN THE UNITED STATES.

Among the beetles of the genus *Dermestes*, treated by Dr. Horace F. Jayne in his paper entitled "A revision of the Dermestidae of the United States" (Proceedings American Philosophical Society, Vol. XX, 1883, p. 353), *D. cadaverinus* Fab. is included, Florida being given as its only locality. Correspondence during September, 1901, shows not alone that this species is apparently established in this country in New York City, but that it is probably an exotic form, perhaps originating in China.

September 6, 1901, the Clifton Silk Mills, town of Union, N. J., sent specimens of this species, with accompanying information that the beetles and their larvæ were found in bales of dried China silk-worm cocoons imported from Shanghai for reeling. Many of the beetles were noticed at this time wandering about among the cocoons, and a lesser number of larvæ. A friend of our correspondents having a silk-reeling establishment in France said that this (or perhaps a related) species emerged from the cocoons when the latter were kept in moist places. Another friend interested in silk culture stated that he found the larvæ or "worms" in bales of reel silk, and that they cut the silk as with a knife, establishing themselves generally beside the cords which tie the bundles, and working their way along the grooves made by the cords, cutting the skeins as they go. He recollected that larvæ had been occasionally found in Italian silk.

Our correspondents stated that the beetles made short flights, but were disinclined to use their wings.

September 14 our correspondents called attention to the small clean holes made by the insects in the cocoons, in contrast to that made by the silkworm moth, which in emerging makes a ragged hole, stained brown for some distance in from the edges. It was further stated that in France, where this species is found in reeling establishments in raw silk, that when the packing of the silk was done near where the cocoons were stored infestation was noticed. By removing the packing department to a distance from the cocoons this trouble was averted.

September 25, 1901, the Payne Spring Tanning Company, Cumberland, Md., sent specimens of this beetle with sample of leather received from a tanner in New York City, showing holes through which the beetles had bored. Our correspondents stated that the leather was rolled in bundles of 12 and 24 sides each, and upon opening the same they found that the leather had numerous holes in it about the size

that would be made by large shot. According to their description, the beetle or its larva would start on one side and cut a hole through an entire bundle of leather. An attempt to disinfect the leather with carbolic acid had no apparent effect.

Writing again September 28, this company stated that there was little doubt that the leather became infested in a hide house in New York City where it had been stored for some time, and where large quantities of foreign hides are handled. Damage of the nature mentioned was common in foreign dry hides, but our correspondents had never known of domestic tanned leather being attacked in this manner before.

All of the material received from the New Jersey and Maryland correspondents from silkworm cocoons and leather, respectively, was referred to Mr. E. A. Schwarz, who pronounced the species *Dermestes cadaverinus* Fab. This species is comparatively rare in the United States, as Dr. Jayne's note on its distribution "merely occurs in Florida" would indicate; but it is one of the many species which affect stored material, and which are thus destined in time to become cosmopolitan.

REMEDIES.

The best remedy for these insects, when they occur in leather and similar substances, is undoubtedly the bisulphid of carbon, and this should be freely used where the insects are most abundant. Where it is possible to remove leather to tight rooms, it can be disinfected in the usual manner; but where this cannot be conveniently done it is more advisable to disinfect entire rooms in the storehouse infested. Silk and cocoons can be even more readily reached by the use of bisulphid of carbon, and this applies to the fumigation of entire rooms; but the hydrocyanic-acid gas treatment can also be employed. This latter is useful where insurance companies object to the use of bisulphid of carbon on account of its inflammability. Directions for the use of bisulphid of carbon are given in Farmers' Bulletin 145, and for fumigation with hydrocyanic-acid gas in Circular 46 (second series), both of which publications can be obtained by application to this office.—F. H. C.

SOME BLISTER BEETLES INJURIOUS TO FRUIT TREES.

For many years past blister beetles of three or four species have been reported at intervals as doing more or less destruction to the foliage of various fruit trees in different portions of our country. The insects in question are quite different from the common species of blister beetles found in potato patches and in fields and gardens generally. They are strictly arboreal, while the latter are terrestrial. Some accounts of recent injury may be of interest, together with the accompanying illustration of one of our best-known forms. All of these insects are handsome creatures of graceful form, and in color different shades of green or olive with yellow or yellow and black legs.

SAY'S BLISTER BEETLE (*Pomphopaea sayi* Lec., fig. 6).—April 29, 1901, Mr. R. J. Black, Bremen, Ohio, sent specimens, as did the other correspondents who will presently be mentioned in connection with this and other species, stating that the beetles were found in great numbers devouring blossoms of Japan plum. The species had not been noticed in previous years, and other varieties of plum, cherry, and peach were not affected. May 13, Mr. C. W. Nash, Toronto, Canada, also reported this species on plum doing great damage to the blossoms.

The PEAR-TREE BLISTER BEETLE (*Pomphopaea penca* Say).—May 1, 1901, Mr. Joseph Hampson, jr., reported this species to be destroying the petals, stamens, and pistils of pear blossoms at Pen Mar, Pa. An invasion of this species on pear was recorded as occurring in central eastern Ohio in 1894 (Ins. Life, Vol. VII, p. 204). In 1898 and 1899 it was reported to be destroying the blossoms of young plum at Wooster, Ohio, and Tazewell, Tenn.

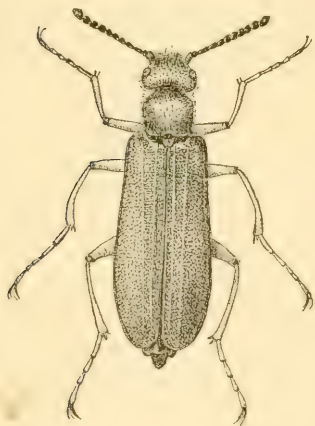


FIG. 6.—*Pomphopaea sayi*: beetle, $2\frac{1}{2}$ times natural size (original).

The TEXAS PLUM BLISTER BEETLE (*Pomphopaea texana* Lec.).—March 18, 1902, Mr. David Hunter, San Antonio, Tex., wrote of the occurrence of this blister beetle on plum in that vicinity. Six years earlier our correspondent had noticed this beetle feeding on Chickasaw plum in Blanco County of the same State.

The PEACH BLISTER BEETLE (*Pomphopaea unguicularis* Lec.).—April 8, 1902, Mr. Franklin Sherman, jr., wrote of the occurrence of this blister beetle at Blowing Rock, N. C., on wild mountain laurel, devouring both blossoms and leaves. It occurred there literally by thousands, attacking also peach trees, eating those which had previously been attacked by leaf curl. The beetles also affected cultivated roses to such an extent that one owner had to resort to spraying to save them. In Volume VI of Insect Life (p. 36) we recorded the occurrence of this species in immense numbers at Whitesides, N. C., where they denuded the locust, *Robinia viscosa*, of foliage. This was at an elevation of 5,000 feet above sea level, and occurred in 1893.

Remedies.—All of these blister beetles undoubtedly feed, in nature, on the blossoms of wild fruits, such as plum, mountain laurel, and the like. On low trees it is not difficult to control them by hand-picking. On higher trees they can be destroyed by means of a spray of Paris green applied in the usual manner. On peach, however, arsenate of lead is best, owing to the danger of scorching the tender foliage of

that tree. Another manner of holding them in check is by jarring them upon curculio-catchers, which can be constructed by means of a sheet stretched and held taut on a frame. If this catcher is saturated with kerosene such insects as come in contact with it will die. As to the success of these remedies, Mr. Hunter, writing of the Texas species, states that it was easily destroyed by hand-picking, as the beetles were not readily disturbed, while Mr. Nash, writing of Say's blister beetle, states that arsenicals could not be applied owing to the danger of killing bees.—F. H. C.

NOTES ON VINE-CHAFFERS.

Recent years have witnessed considerable injury locally and, as usual, periodically to grapevine and the foliage and blossoms of various fruit trees by some species of beetles of the genus *Anomala*. Of the dozen described forms of this genus, four are known to affect the grape; hence the name of vine-chafer, which is rather commonly bestowed on them.

Anomala undulata Mels.—This, one of the commonest species, has been reported during the last two years at Gadsden, Ala., and Tazewell, Tenn. In the first locality the beetles were first noticed by Mr. C. W. Ewing, April 10 at sunset, flying in great numbers from a valley below and settling on peach trees, where they ate both blossoms and leaves. In the latter locality, Mr. H. Y. Hughes observed the beetles destroying buds, bloom, and young fruit of cherry. In earlier years we have recorded the occurrence of this species as injurious to the blossoms of grape, apple, and pear at Grand Bay, Ala., and to grape at Greenville, S. C.



FIG. 7.—*Anomala undulata*: beetle, four times natural size (original).

The life history of this species is in some respects like that of the common rose chafer, which is treated in Circular No. 11 of this Division. The beetle, however, is quite different in appearance. It is shown in fig. 7. The color is shining pale yellow, with the thorax mostly black, and the elytra or wing covers spotted with black, much as illustrated, the pattern, however, being quite variable.

Anomala marginata Fab.—This, the margined vine-chafer has been quite destructive recently at Carterton, Va. Dr. E. K. Harding reports that it occurred in June, 1900, about the middle of the month, and did considerable damage to cherry and Japan walnut, but did not trouble the vine. Many holes were found in the earth under the trees, and when the beetles were shaken off they disappeared into the ground, an occurrence which led our correspondent to infer that eggs might be deposited in the earth from which the larvæ would hatch. This is

probably true. The beetles, like the rose chafer, were seen in copulation at any hour during the day. Subsequent observations showed that these beetles also occurred in abundance on sycamore and that they even relished the acrid foliage on black walnut.

The beetles also resembled the rose chafer in their sudden appearance, their time of activity (about one month), and their equally sudden disappearance at the end of that time.

Anomala minuta Burm.—The black form of this species was received May 2, 1901, from Mr. B. H. Frazier, Fruitdale, Ala., where it was observed working on young peach and plum trees set out that spring. The beetles burrowed in the ground around the trees to a depth of 1 to 3 inches into the moist earth. They ate only the young, tender leaves. It was also noticed that they seemed to be most numerous in the drier and sandier soil of that vicinity, which suggests that the larvæ probably fed on grasses grown in such locations.

While writing of the habits of these vine chafers it may be well to add that on one occasion *A. undulata* was observed affecting growing wheat, in another case attacking petunias, and in still another affecting grape. *A. marginata* is most commonly found on the vine, as is also *minuta*. *A. lucicola* is also a grape-feeding species, and *binotata* has been found on the grape as well as on strawberry and locust.

Remedies.—In the treatment of these vine chafers we have practically the same problem, in many cases, as in dealing with the rose chafer. The beetles frequently occur in such numbers and devour the leaves of young and tender fruit trees so rapidly that Paris green does not produce the desired effects. In ordinary cases, however, an arsenical spray is sufficient for their destruction. Dr. Harding has met with good success both with spraying and with shaking the beetles off and burning them, in much the same manner as described in connection with the blister beetles which affect fruit trees.—F. H. C.

THE COLORADO POTATO BEETLE IN THE SOUTH.

We have recently received information from many correspondents in Southern localities furnishing evidence that the Colorado potato beetle (*Doryphora 10-lineata* Say) has been making a general effort to extend its range southward. Such migration has been noticed for a number of years past, but has never been so noticeable as during the season of 1901. The species will doubtless continue to spread southward until it is overcome by natural enemies or perhaps killed out by the weather. It has been noticed that this species has been destroyed in great numbers during severe dry spells, such as was experienced during the summer of 1900, the larvæ being literally dried up on their food plants.

Our first information in regard to recent spread by this species was from Mr. N. L. Willet, of Augusta, Ga. For the first time in his remembrance, that section was being devastated. He wrote, May 12,

1900, that within a radius of about 100 miles the country was being devastated, his drug firm receiving daily orders from railroads radiating from the city for Paris green, more of this insecticide being sold in the previous week than in the preceding four years. The opinion was expressed that in future the inhabitants of that region might have to count upon this beetle as one of the expected annual arrivals in spring. The country round about appeared to be alive with them.

May 14, 1901, Maj. Harry Hammond wrote of this species and its destruction of potatoes in the vicinity of Beech Island, S. C. May 24 Mr. John Conner, Ripley, Tenn., wrote of injury in Lauderdale County. The insects were first noticed about the middle of May, and by the end of the month early potatoes were entirely stripped of their leaves. A similar report of injury was received from Mr. Albert E. Seddon, Atlanta, Ga., May 25.

Mr. J. P. Rudolph, Pleasant Hill, Ala., wrote May 27 that the Colorado potato beetle made its first appearance in that locality that year, but the timely application of Paris green checked its ravages.

June 4 we received a communication from Mr. J. C. Russell, Clarksville, Tex., in regard to the occurrence of the insect in that vicinity.

It should be remarked that Mr. H. E. Weed, when entomologist of the Mississippi Agricultural College Experiment Station, writing of this species in 1897, published a map showing that in 1896 it had occupied the northern two-thirds of Mississippi, the prediction being made at that time that owing to the large increase in the acreage devoted to Irish potato in that State and throughout the South it was probable that the insect would continue its southward spread to the Gulf of Mexico (Bul. 41, Miss. Agr. Exp. Sta., Mar., 1897, pp. 186, 187).

THE RICE WEEVIL AN IMPORTANT FACTOR IN THE FAILURE OF GERMINATION OF CORN IN THE SOUTH.

In the course of investigations conducted by Mr. E. A. Schwarz, of this office, in Texas, to place the hibernation of the Mexican cotton-boll weevil, it was ascertained that not only the boll weevil but the rice weevil (*Cilandra oryza* Linn.) or so-called corn weevil, as it is better known in that portion of the South, made use of cornstalks for winter quarters. Only a few of the boll weevil were observed in comparison to thousands of the rice weevil that habitually hibernate in this manner. The latter beetle also sometimes passes the winter in cotton bolls and in other plants, but cornstalks, owing to the greater degree of moisture which they contain in the pith, form a favorite winter home of this insect. Thus it happens that the careless farmer has to contend not only with the weevils that are present in his corn when planted, but with others which come out of the cornstalks on the approach of warm weather and undoubtedly dig down into the soil to the kernels.

Frequent complaint has been made of the failure of corn to grow in the South, and this explains the reason to a very considerable extent. Most of Mr. Schwarz's observations were made in the vicinity of Victoria, and he related having seen long, uninterrupted rows of these beetles on fences when warm weather tempted them from their places of concealment. Mr. Schwarz brought with him specimens of corn seed that had been planted showing the holes made by the ravages of this insect, which ate out the germ, leaving the remainder practically intact. The farmers usually attributed this failure of germination to crows and other birds, and the truth has never been ascertained hitherto.

The necessity of selecting good seed for planting has been pointed

out in Farmers' Bulletin 45, on insects affecting stored grains, as well as in a pamphlet entitled "Insects Injurious to Beans and Peas." It is now in order to advise cleaner culture, consisting of the destruction of cornstalks before the insects which have hibernated in them issue. This is a measure of the greatest value not only in controlling the rice weevil, but many other granary insects which lead a more or less outdoor existence in the South, such as the grain beetles, *Silvanus* and *Cathartus*, and

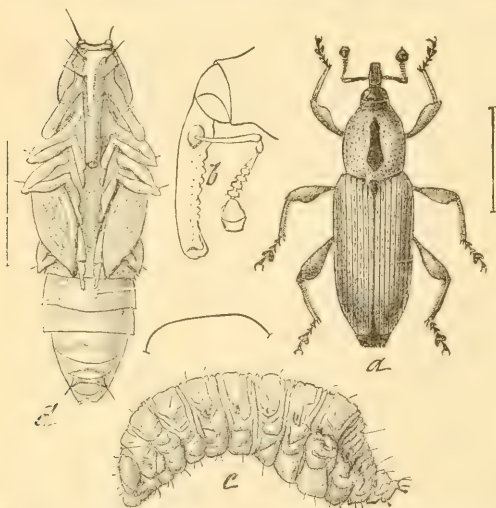


FIG. 8.—*Sphenophorus obscurus*: a, adult, enlarged; b, head of adult, from side, still more enlarged; c, full-grown larva, from side; d, pupa, ventral view, both enlarged (from Insect Life).

the flour beetles, *Tribolium*, etc., and some other species.

THE SANDWICH ISLAND SUGAR-CANE BORER AGAIN.

It may be remembered by our older correspondents that we published in Volume I of *Insect Life*, on pages 185-189, an illustrated account of *Sphenophorus obscurus* Boisd., which we may call the Sandwich Island sugar-cane borer. We have several times received this species from different sources, and some articles and shorter notes have been published in regard to it, most of which are referred to in the article cited. February 18, 1902, Mr. Jared G. Smith, special agent of this Department in charge of the Hawaii Experimental Station at Honolulu, Hawaiian Islands, wrote us from Spreckelsville, Maui, in regard to severe injuries by this insect. As some of our

present readers may not have access to the volume of *Insect Life* to which we have referred, the illustrations there presented are reproduced (figs. 8 and 9). Mr. Smith writes substantially as follows:

I am sending you herewith specimens of the cane-borer which infests the sugar-cane plant throughout the rainy districts of Hawaii. It is quite rare in the dry districts or in dry years, but is terribly destructive in wet years or on plantations in regions with abundant rainfall. On one plantation on Maui the loss last year from the cane-borer was estimated at between 1,000 and 1,500 tons of sugar—20 per cent of the crop. At an average price for sugar of \$70 per ton it is not difficult to figure up a pretty stiff bill against the cane-borer.

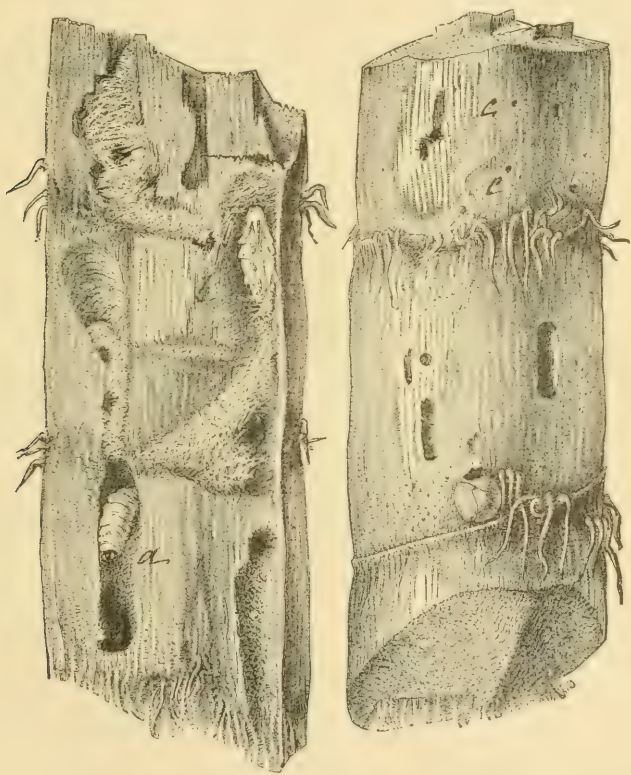


FIG. 9.—Sections of sugar cane showing work of *Sphenophorus obscurus*: a, larva; b, pupa, *in situ*; c, probably points of oviposition, somewhat reduced (from *Insect Life*).

From its habits I judge there is no hope of trapping, poisoning, or otherwise destroying it, and it looks as though we would have to find a natural enemy for it. The toad has been tried, but the mongoose is too fond of toad for breakfast.

The eggs are apparently laid in the sheath of the old leaves of the cane a little above its junction with the node. The egg hatches out in the sheath and the young grub eats its way into the cane just above the node. The hole where it enters is very small and hardly visible. Once inside the grub grows rapidly and channels back and forth, rapidly converting the lower internodes into a mass of feces. The grub pupates in the cane and only emerges from the stalk as a beetle to copulate, and do it all over again. Several of those which I send were caught in the act. The

imagos are found inside the sheaths of the dead leaves on the lower part of the stalk during the daytime, and apparently only fly at night.

Not being an entomologist, I don't know what other information would be of value to you. The grub is found only in the mature basal joints of the cane stalk—the portion of the stalk which is richest in sugar. I do not think that the imago is attracted by light; anyway it would be dangerous to have a light in a cane field on account of the danger of fire.

Ten tons of cane per acre are sometimes destroyed by the borer.

Since writing the above I have talked with Mr. A. Koebele. He says the borer is probably a native of Tahiti, or at least that it was introduced here from there, but that it also occurs in Samoa, Fiji, New Guinea, and other southern Pacific island groups. Also that it infests the banana, wine palm (*Caryota urens*) and other palms, the papaya (*Carica papaya*), and a good many other tropical crops.

Hon. H. P. Baldwin, who gave me most of the preceding information, says that the cane borer is the worst insect pest in Hawaii, and that a conservative estimate of the amount of damage done by it would be at least \$500,000 per annum.

UMBRELLA ANTS IN CUBA.

During the first week of June we received two communications in regard to an ant native to Cuba and designated by the natives as “bibijagua.” Mr. Thomas R. Towns, Quiebra Hacha, province of Pinar del Rio, wrote May 27 that this insect, which is probably *Atta insularis* or a related species, is as industrious as any animal alive, working as late as 12 o'clock at night, when the dew puts a stop to its work. At 10 next day it is out again. The ants stripped a nursery of every leaf of orange, showing a preference for the tender leaves. They are described as taking a row of young stock about an eighth of a mile long, tree by tree, never missing one nor leaving a leaf. When this row is finished they take the next. Our correspondent stated that he “ran them out” by tarring a rope with pine tar and laying this around the plot attacked.

Mr. E. T. Fries, Santa Fé, Isle of Pines, complained of the same species and its injury to orange. He had noticed its habit of living in colonies in immense hills of earth, with galleries, chambers and tunnels, and with well-beaten paths in many directions leading to the hill. Along these the ants traveled, each carrying a bit of leaf often several times as large as the ant itself. The ants are officered by one of larger size.

THE GAGE BUG.

During the time that this Division issued the periodical publication, Insect Life, which reached an edition of seven volumes and has now been discontinued, we had frequent occasion to mention the popular names of our common insects. Such notes as we published frequently elicited interesting correspondence.

January 30, 1902, Mr. James Riley, of New Dorchester, Mass., wrote in regard to popular names, giving an account of the “Gage

bug," which we reproduce below in its entirety. There is little doubt, from the description of the insect, as chunky and not flying, that he has reference to the common squash bug, a well-known enemy of pumpkin and squash vines. It is probable that General Gage did not have a very extensive knowledge of entomology, and judged this insect to be more destructive than it really was, owing to its somewhat disgusting appearance and still more displeasing odor. The following is in reference to one of the Entomologist's lectures delivered at the Lowell Institute during the month of January:

In common with all your auditors I have been pleased and instructed with your heart and head talks on insect life. I was waiting all the time to hear of one of my old enemies, the Gage bugs. You may have mentioned them in your second lecture, which I missed. They may have been the Hessian fly, but if my memory serves they came with them, but were more chunky, and did not fly. I was reminded of them when in your first lecture you said that people often named pests after what they disliked, as the French weed in English-speaking Canada and the Abe Lincoln bug in Georgia. So too with the Gage bug. The old man who brought me up was an Alden but five generations from the historic John. He used to tell me in hoeing time (in the late 50's and early 60's of the century that was) that General Gage after the battle of Bunker Hill, finding he could not "whip us," went up on the hill the next day and, opening his snuff box, let out the bugs that we were then killing on our pumpkin and squash vines. He would describe most lucidly the battle before telling the story, and so I never stooped to "squash" a Gage bug in those days without seeing a general in red on a high hill, snuff box in hand, out of which issued a living line of pestilence as the bugs swarmed in perspective down the thirteen colonies. Such was a lesson in natural and political history of an old-time Yankee to an Irish boy forty years ago.

THE PROBABILITY OF THE OCCURRENCE OF THE MEXICAN COTTON-BOLL WEEVIL IN BRAZIL.

We have received information leading toward the conclusion that the cotton-boll weevil (*Anthonomus grandis* Boh.), or an insect of very similar habits, has been present for some years in the cotton regions of Brazil, notably in the State of Bahia. Professor d'Utra, director of the State agricultural station of São Paulo, has written a rather extensive article upon this subject, in which he considers that there is no doubt that the insect is *Anthonomus grandis* (Boletim de Agricultura, 2d ser., No. 4, pp. 211-229, 1901). In our efforts to obtain specimens we have been favored by Prof. Adolph Hempel, of the same station, with the information that, although there may be some uncertainty about the identification, the fact remains that in the State of Bahia there occurs a small beetle that lives in the cotton bolls, especially within the seeds. This describes exactly the method of work of the boll weevil in southern Mexico and Central America, as noted by Townsend, though in Texas it never occurs within the seeds.

In the absence of specimens only speculations regarding this matter are to be indulged in. There is, however, an authentic record of

the occurrence of this insect in Cuba in 1871. Nevertheless, it is practically certain that in 1882, at the time of the visit of Branner and Koebele to Brazil, *Anthrenus grandis* did not exist as an enemy of cotton in the State of Bahia or elsewhere in that country. Moreover, none of the principal works dealing with the Coleoptera of that portion of South America mentions the species. Although this by no means demonstrates that *Anthrenus grandis* may not now be found there, it certainly tends to indicate that if the species has made its way into Brazil, it has, in less than twenty years, increased its range remarkably.—W. D. H.

THE ST. ANDREW'S COTTON STAINER.

Mr. J. J. de Barril, the proprietor of a cotton plantation in the interior of Cuba, has given us interesting details concerning *Dysdercus andrew* L. This species, like *D. suturellus* H.-S. of the southeastern United States, is a cotton stainer. It sometimes occurs in such numbers that if cotton culture is again engaged in extensively in the West Indies it may become considerably more important there than its congener in this country, which has for many years ranked as a pest of only secondary importance.

Some years ago this insect was the subject of one of Prof. T. D. A. Cockerell's stylographic notes (Institute of Jamaica, Notes from the Museum, No. 9, Feb. 24, 1892). The common name we have used was suggested by Professor Cockerell, and is in allusion to the white cross formed by the markings on the hemelytra which Linnaeus also referred to in the Latin name he gave the species. In the adults this coloration is quite striking. More than a century ago Sloane, a traveler in Jamaica, referred to the insect as "a Cimex of a scarlet colour with a white St. Andrew's cross on its back. This is one-third of an inch in length. It is very often to be met with amongst flowers."

Our correspondent states that on his plantation, where until last year no cotton had been planted for nearly half a century, the cotton bolls were frequently so covered that nothing but a mass of red and black insects was visible. This happened in January and February, before the fruit opened, and no effect upon the plant, except that of dwarfing the bolls, was observed. Toward the end of March, however, when all of the bolls had burst open and most of the staple had been gathered, the pests fell upon what remained, and then the staining of the fiber became most noticeable. The color of the stain was yellowish brown or ferruginous. Another observation suggests a probable effective method of destroying the pests. All the hollows of stumps or trees in the cotton fields were noticed to be filled by millions of the immature insects. These did not eat the leaves of the cotton plant, but were found crawling over the grass and tobacco

plants which were planted in the vicinity of the cotton. In these situations it would be an easy matter to destroy the pests by means of hot water, or kerosene emulsion, or a mechanical mixture of kerosene and water.

The species is generally distributed in the West Indies. It has been reported from San Domingo, Jamaica, and St. John, and Mr. O. Heidemann's collection contains specimens from Cuba and Montserrat. It did not appear, however, in the extensive Smith collection of Hemiptera from Granada, W. I., and likewise seems to be unknown in Mexico and Central America.—W. D. H.

STOPPAGE OF ELECTRIC LIGHTS BY INSECTS.

The Electrical World and Engineer of August 9, 1901, says that recently at St. Paul, Minn., the electric lights were stopped by an accumulation of shad flies, 18 inches from wire to wire, shutting off the current of 25,000 volts. The shut down by a short circuit between the wires lasted an hour, and it was found necessary to station an attendant to remove the constantly accumulating insects with a hoe. The figure illustrating the article represented a *Bibio*, but the text says that the creatures were shad flies.

A VARIETY OF WHEAT SAID TO BE IMMUNE FROM HESSIAN FLY.

Maj. William R. King, ex-chief of the seed division, Department of Agriculture, returning from Buffalo, and having interviewed several New York wheat growers, reports that he is authoritatively informed that the only variety of wheat which practically escaped the great damage which the Hessian fly did in that part of the State during the season of 1901 is Dawson's Golden Chaff. The peculiarity in the wheat is that the straw is very stiff and tillers abundantly. It originated at Guelph, Ontario, Canada, at the Dominion Experimental Farms. It has been extensively planted in Canada, also in western Michigan, not only at the Agricultural College, but in the vicinity of Grand Rapids.

A WESTERN CRICKET IN OREGON.

July 30, 1901, Mr. R. J. Hollis sent specimens of one of the so-called western crickets (*Ambrus purpurascens* Uhl.) from Andrews, Harney County, Oreg. Our correspondent had never seen this species in California or elsewhere, but knew that it was a yearly visitor in the vicinity from which he wrote, staying about six weeks, after which it either died or disappeared in some unexplained manner. It was noticed that it was migratory. In some places there were millions of them, and they ate everything from garden truck to leather and canvas, and even each other. They appeared to be sensitive to heat and cold, and were described as herding together like hogs during the

night, while in the hottest part of the day they got under cover out of the sun. It was an interesting sight to see so many of them jumping and hopping like frogs. They were so large and ravenous that it took much vegetation to appease their appetites. They soon cleaned out a garden. The species appears to be peculiar to arid regions.

NOTES FROM CORRESPONDENCE.

Tobacco for mushroom fumigation.—John T. Cochran, Claymont, Del., writes that tobacco fumigation has been practiced with some success for mushrooms. It did not entirely remove the insects, but killed many of them. Our correspondent believes that a mild fumigation, as suggested by us, with tobacco stems at frequent intervals before the crop begins to show, will keep down insect pests.

Insect injury in Texas.—Mr. John Nagle, a Texas correspondent, of Gainesville, Cook County, writes under date of July 4, 1902, that every year the State loses 25 per cent of all crops through insect depredations, not including losses from other causes, the latter modifying clause being added because the year 1902 at that time gave promise of being one of great deprivation, as many farmers would suffer for the bare necessities of life in that portion of the State at least, where people were going 10 miles for water for use on their farms.

The apple twig-borer (*Amphicerus bicaudatus* Say) **injuring honey locust.**—This species, which is also called grape cane-borer and which is known to attack a variety of fruit, forest, and shade trees as well as shrubs, was received May 24, 1902, from Mr. W. S. Robb, Lacrosse, Kans., who reported that it was feeding on honey locust. As in the case of attack to apple, the beetles perforate the bark near a bud, thorn, or branch, generally above, and work directly toward the heart.

The pear-blight beetle in the Pacific region.—May 23, 1902, Mr. Harry G. Smith, Vancouver, Wash., sent twigs of Italian prune injured by this species, known also as the shot-hole borer (*Xyleborus dispar* Fab.), with the information that considerable injury was done in that region. Mr. Smith stated that the proportion of trees killed in his young orchard was about 10 to 75. June 12 we received a package of specimens from Ely, Oreg., containing beetles and a score or so of bits of twigs showing injury by this insect. These are the first instances of injury to our knowledge that have been recorded for this species in the far West. It would be interesting to learn how general the attack is, and whether the insects were introduced from our Eastern States, where the species has been present for half a century or more, or from Asia, where it occurs in Siberia.

Peculiar larval habits of a leaf-beetle affecting prickly ash.—During 1901 and 1902 Mr. J. D. Mitchell, Victoria, Tex., sent specimens of *Trichabala brevicollis*, stating under date of May 4 of the former year that the larvæ burrow into the ground where it is slightly raised, making runs or galleries, from which they crawl out and about day and night, but never more than a few inches from the colony home. The following year he reported that he had found a large colony tunneling into a small hillock and crawling around on the surface of the ground, and had observed also that the pupal stage was passed in the ground, the mature insects issuing about ten days from the time that the larvæ disappeared. May 7, 1902, he noted that a large colony of the beetles, which are not unlike the common elm leaf-beetle (*Galerucella luteola*) in appearance, had about ten days later completely defoliated a large prickly ash (*Xanthoxylum americanum*). As with other species of this genus, the beetles are very sluggish, seldom flying, and dropping to the ground when touched or disturbed, and crawling slowly. Mr. E. A. Schwarz, of this office, has observed the same species at Victoria, Tex., often entirely defoliating the brush-like trees of this worthless plant. What is considered to be the same species which occurs in Michigan and all over the Eastern States wherever this plant occurs.

Blister beetles attracted to lights.—Mr. Otto Holstein, Cline, Tex., wrote during August, 1901, that he succeeded in getting rid of blister beetles as well as other insects by placing a lighted lamp in a basin of water; the insects flying about the light invariably fell into the water and drowned, a little oil upon the surface rendering it impossible for them to escape. This is an old-time remedy against a number of insects, and it is well known that blister beetles are frequently attracted to lights in considerable numbers. The trouble with this remedy, however, is that it is apt to destroy also many beneficial insects.

Parasites of the tent caterpillar (*Clisiocampa americana* Harr.).—Writing June 17, 1902, Mr. F. E. Brooks, Frenchcreek, W. Va., sent specimens of parasites of this species, with report that out of 43 cocoons collected on apple trees 9 yielded moths and 8 the tachina fly (*Frontina frenchii* Will.), while all the remainder gave 201 individuals of the ichneumon (*Pimpla maura* Cr.). Later, our correspondent sent two chalcis fly parasites (*Miotropis clisiocampæ* Ashm. and *Dibrachys boucheanus* Ratz.), as well as a species of Compoplegine from the same host.

Parasites of the plum curculio.—Mr. Brooks also sends us from the same locality a Braconid parasite of the plum curculio (*Conotrachelus nemuphar*), viz: *Bracon melitor* Say; and a chalcis fly, a species of *Eurytoma*, also a parasite of the curculio.

Note on Pogonomyrmex barbatus, one of the agricultural ants of Texas.—Mr. G. M. Dodge has recently sent specimens of this ant, together with samples of seeds on which he observed it feeding at Ingram, Kerr County, Tex. These seeds have been identified by Mr. A. J. Pieters, of the Bureau of Plant Industry of this Department, as Texan grama (*Bouteloua texana*), sand bur (*Cenchrus tribuloides*), and lance-leaved sage (*Salvia lanceolata*). Our correspondent stated that he had seen the ants harvesting these seeds.

A Cimbex in British Burma.—Mr. George Field, of Washington, an importer of orchids, found attached to the roots of *Dendrobium wardianum*, an orchid from British Burma, a rough, brown silken cocoon from which issued May 17, 1902, in the insectary of this Department, a new species of sawfly of the genus *Cimbex*. This fact is of very considerable interest, since it seems that no species of this genus has ever been taken in Farther India.

Note on the ox warble in Mississippi.—March 27, 1902, Mr. Lawrence C. Johnson, geologist, Pachuta, Miss., wrote in regard to this species, which is also called the ox bot or heel fly (*Hypoderma lineata* Vill.), stating that about two weeks prior to the date of writing, with the first spring-like weather, this species had appeared in large numbers and had proved a great torment to cattle. The insect did not confine itself to attack on the heel, this, according to popular belief, being because the cattle stamped so much.

Christian Science for Cattle.—Mr. Franklin, formerly district attorney at San Antonio, Tex., vouches for the fact that two cattle owners at Llano, Tex., treat their cows for screw worms by Christian Science.

Scavenger flies as a creamery pest.—A correspondent at Garrison, Mo., writing May 16, 1902, transmitted specimens of the fly *Calliphora viridescens* Desv., with the report that these insects were new, and that they were troublesome in a room where milk was kept. They laid eggs in the cream when it was nearly sweet and beginning to turn. They did not appear to infest the butter, but tried to get into the sweet milk.

Notes on kissing bugs.—June 28, 1902, we received a specimen of *Reduvius personatus* Linn., from Mr. W. T. Hubbell, Philo, Ohio, with the information that it was caught in the night within the folds of a lady's nightdress after twice stinging her. The lady described the sensation as like the sting of a wasp, causing sickness and something like a chill, symptoms which, however, might have been due to nervousness, as the lady was not very strong.

July 28, 1902, Mr. J. C. M. Johnston, New Wilmington, Pa., sent a minute larva of a lace-winged fly (*Chrysopa* sp.), with report that it had bitten him on the hand,

and the sensation which followed was similar to that due to the bite of a mosquito, but no inflammation took place.

Tobacco as a remedy for grape leaf-hoppers.—Mr. Fred W. Card, Kingston, R. I., writes October 19, 1901, that a Mr. Saunders found tobacco stems on the floor of his grapyery an effective remedy against grape "thrips" or leaf-hoppers (*Typhlocyba*). Mr. Card also suggested that after thoroughly clearing out the leaves and refuse during the fall the vines and houses should be thoroughly sprayed with kerosene emulsion.

The use of harvest spiders in medicine.—A correspondent from South Carolina sends us specimens of *Liobunum formosum* Wood, with the legs removed and the bodies packed carefully in gelatine capsules, with the remark that he has found them a sure cure for malarial fevers.

Negro superstition in regard to stinging ants.—The negroes of Louisiana have a superstition, an animistic belief in the little ant, which we call the bulldog ant (*Mutillid*) for the reason that it is always running around hunting other insects, that if they cook this in a piece of corn bread or mush and feed it to a young pup that it will make a good hunting dog out of the pup. As a general thing, this has to be done by some old hoodoo doctor. I went to work and did the thing myself, and the results were not satisfactory. So I told him it didn't pan out, and he said: "Well, that is because you didn't send for me. Give him to me, and I'll fix that dog up."—*E. S. Hallock, Washington, D. C.*

Successful infection of a wireworm with *Cordyceps* fungus.—July 6, 1902, Mr. C. W. Nash, Toronto, Canada, wrote that he had been successful in infecting the larva of an Elaterid beetle with a fungus disease, a species of *Cordyceps*. Somewhat prior to the date of writing, larvæ were noticed affected by this disease, and the spores were confined with other larvæ received from a distance, with the result that several of these larvæ were taken with the disease. Writing later, July 21, our correspondent sent a specimen of infected wireworm which Mr. E. A. Schwarz has identified as a species of *Drasterius*, and with little doubt *dorsalis*. This specimen had the fungus growing from the side of the head. The fungus was described as growing straight up until it reached the top of the jar in which it was confined. The specimen sent measured between 4 and 4½ inches.

Cutworm injury to ginseng.—Mr. George Adams, Detroit, Mich., writes in regard to injury done by cutworms to 2,000 valuable ginseng plants (*Aralia quinquefolium*). He states that they were all gnawed off at night, and that the plants were vigorous and healthy until cut down. In Pulaski County, Mich., he states that ginseng seed is selling at from \$5 an ounce to \$120 a pound, and that he had lost his entire crop of seed for the year.

The unicorn worm in a new role.—Under date of July 29, 1902, Mr. C. P. Crowell, Rochester, N. Y., sent a specimen of the larvæ of *Schizura unicornis* S. & A., with report that it was devouring the leaves of plum in that vicinity, literally eating everything as it went, leaves and plant-lice included. This insect, as is well known, is a rather general feeder on deciduous woody plants, but its habit of feeding on Aphides has not been recorded to our knowledge.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ENTOMOLOGY—BULLETIN NO. 38, NEW SERIES.

(Revised Edition.)

L. O. HOWARD, Entomologist.

SOME

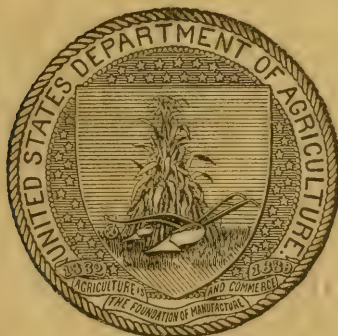
MISCELLANEOUS RESULTS

OF THE

WORK OF THE DIVISION OF ENTOMOLOGY.

V I .

PREPARED UNDER THE DIRECTION OF THE ENTOMOLOGIST.



WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1904.

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U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF ENTOMOLOGY—BULLETIN NO. 38, NEW SERIES.

(Revised Edition.)

L. O. HOWARD, Entomologist.

S O M E

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY,
Washington, July 22, 1904.

SIR: I have the honor to transmit revised copy of several articles and shorter notes, none of which are of such a nature as to justify their publication in separate form. The matter presented is similar to that which has been published in other bulletins of this series, namely, in Bulletins 7, 10, 18, 22, and 30; and I recommend the publication of the present material under the title "Miscellaneous Results of the Division of Entomology, VI," as Bulletin No. 38, new series, revised, of this Bureau.

Respectfully,

L. O. HOWARD,
Entomologist.

HON. JAMES WILSON,
Secretary of Agriculture.

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SOME MISCELLANEOUS RESULTS OF THE WORK OF THE DIVISION OF ENTOMOLOGY.

VI.

THE SOUTHERN GRAIN LOUSE.

(*Toxoptera graminum* Rondani.)

By THEO. PERGANDE.

INTRODUCTION.

Aphis graminum Rond., Nuovi Ann. della Science, Series III, Vol. VI, p. 10, 1852.

Toxoptera graminum Passerini, Aphididæ Italicæ, p. 28, 1863.

This destructive little Aphidid was first observed and described under the name of *Aphis graminum* by Dr. C. Rondani, who stated that the winged migrants were swarming during the month of June in immense numbers in the streets of Bologna to the great annoyance of the inhabitants. In connection with his description he gives a list of the following graminaceous plants on which this plant-louse had been observed to feed: Oats (*Avena sativa* and *elatior*); wheat (*Triticum vulgare*); spelt (*Triticum spelta*); couch grass (*Triticum repens*); *Hordeum marinum*; soft chess (*Bromus mollis*), and corn (*Zea mais*).

A lengthy article on the grain aphis was also published the same year by Dr. Dom. Luigi Mazzanti (Nuov. Ann. Sc. Nat. Bologna, Ser. III, Vol. 6, pp. 342-352), which I have been unable to consult.

Dr. J. Passerini redescribed this species in 1863 (Aphididæ Italicæ, Genoa, pp. 28, 29), removing it to Koch's genus *Toxoptera*. He mentions as its food plants *Triticum*, *Hordeum*, *Avena*, *Zea*, and *Sorghum*. The same food plants were also mentioned by Passerini (Flora degli Afidi Italiani; Bul. Soc. Ent. Ital., Vol. III, pp. 151, 248, 340, and 343).

In 1884 Dr. G. Horvath, of Budapest, Hungary, published some observations on this species ("Rovartoni Lapok," vol. 1, pp. 143-145 and XIX, and a second article on the same insect in "Fauna Regni Hungariæ," p. 60, 1897), dividing the area infested by it into regions, Regions I-IV comprising the central, eastern, and northern sections, and VI the southernmost central area. Neither of these publications is at my command.

An interesting article on the destructiveness of this species to oats was published by Dr. Karl Sajo, Budapest, Hungary (Zeitschrift für

Pflanzenkrankheiten, Beiträge zur landwirthschaftlichen Insektenkunde, Vol. IV, p. 4, 1894). He says:

Fifteen or sixteen years ago I always raised excellent oats on a field bordering a meadow; all of the plants were of a strong and healthy growth, and about one meter in height. Later, however, notwithstanding heavy manuring, the stalks became gradually more slender and lower, and the crop of the grain so scant as not to pay for cultivation. Happening once to inspect the grain during summer at the proper time, I found that the cause of the decline was a plant-louse, which Dr. Geza v. Horvath, at Keeskemét, in 1884, discovered to be the cause of "reddening" of the leaves and the total destruction of the young plants, and which proved to be the grain aphid, *Toxoptera graminis* Rond.

It occurred to me that, by abandoning the common or Bauern oats and replacing it by finer and stronger varieties, they might be able to successfully withstand the attacks of the *Toxoptera*. I was, however, much mistaken. I planted on some of my best fields adjoining the meadow a row of triumph oats, Anderbeck oats, and the common Bauern oats, and found that lice showed a decided preference for the finer varieties with broad, bandlike, and juicy leaves, particularly the triumph oats. Of this variety absolutely nothing was left; all of the plants were destroyed before they reached a few inches in height; the whole field was completely ruined as if it had been swept by fire. Anderbeck oats resisted somewhat, though not much better, whereas the common oats showed the best results, of which at least half a crop was obtained.

I am of the opinion that this invasion of the aphides had its origin in the meadow, because the trouble began first along the edge of the meadow and spread gradually to the middle of the field. Unfortunately all of my fields suitable for the cultivation of oats are in the immediate neighborhood of meadows or along patches of grass, while the more distant fields are of a sandy nature and can only be used for cultivation of rye, corn, etc., which renders a comparison impossible.

The consequences, therefore, were that I had to reduce the cultivation of oats to a minimum and to replace it with fodder corn, turnips, clover, etc.

Professor Sajo (p. 150, loc. cit.) says that this species has probably nowhere else, except in Hungary, shown itself to be so destructive, but that in Hungary it is one of the most destructive enemies of barley and oats. He states that its destructive habits were first described by Dr. G. v. Horvath, who discovered it to be the cause of the reddening of the oats at Keeskemét, and that during the following years similar complaints were reported from the provinces of Baes-Bodrog, Borsod, and Csanad.

The latest contributions regarding the food plants of this species were published by Dr. Giac. Del Guercio (Nuove Relazioni R. Staz. di Entom. Agraria, Firenze, serie prima, No. 2; Prospetto Dell' Afidofauna Italica, p. 145, 1900) with the statement that this plant louse is found in considerable numbers on *Triticum vulgare*, *Hordeum vulgare*, *Avena sativa*, *Zea mais*, *Dactylis glomerata*, *Bromus* sp., and *Lolium perenne*.

HISTORY OF THE SPECIES IN AMERICA.

The earliest record in the possession of the U. S. Department of Agriculture of the presence of this pest in the United States dates

back to June, 1882. Unfortunately, however, the locality from which the insects were received was not obtained.

In June of 1884 this species was discovered on wheat at Cabin John Bridge, Md., though not in sufficient numbers to cause any appreciable damage. During summer and fall of the same year, and January of 1885, specimens were observed by Prof. F. M. Webster at Oxford, Ind., on wheat transferred from the field to breeding cages, in which they continued to breed and multiply, enabling him to make some interesting observations on the rapidity of reproduction of the species. On isolating some pupæ, which soon became winged, he found that during the following twenty days they produced about 40 young, or at a rate of 1 to 4 a day; as a rule, however, the apterous or wingless females are still more prolific.

During June of 1890, after an intermission of about five or six years, this grain louse again became quite abundant, and was found in Indiana by Professor Webster in injurious numbers upon wheat at Lafayette and in southern portions of the State, while in Posey County, in the extreme southwestern section, they were so numerous, both on the fully developed and on the tender unfolding leaves of wheat, as to cover them in some cases completely. The oat crop was a total failure; many of the fields were as brown as though the plants had been winter-killed. During the same year they spread over a large area of some of the grain-producing States of the South. They were first reported about the middle of January by Mr. P. C. Newkirk, Jalapa, Monroe County, Tenn., as being very injurious, killing all the wheat in his section. The following March he wrote again that the insects had not been able to survive the heavy rains and frost of the month, as far as he could see, though much damage had been done to wheat, patches the size of an acre or more being apparently dead, and he had doubts that one of his fields would recover from the damage done.

January 29, 1890, it was reported by Mr. B. F. White, Mebane, Alamance County, N. C., as ruining all the wheat and oats there. February 26 specimens of this insect were sent to this office by Mr. J. L. Fookes, Era, Cook County, Tex., with the statement that the species had played sad havoc with the wheat in that section. In a communication of the 31st of March Mr. Fookes writes:

You ask me about the amount of damage done to the crop and how long they have abounded in our fields. It is believed now that they have been in the fields since early fall; they still remain in great numbers in some fields. As to the amount of damage, we place it, after a careful estimate, at 75 per cent in one-half of this county, which includes the wheat belt. One-half will be planted in other crops and the remainder will be about one-half stand. There are some small crops of Fultz wheat which are not hurt. The rest of the crop is Mediterranean wheat.

Early in April specimens were received from Mr. D. J. Eddleman, Denton, Denton County, Tex., with the statement that the species was

destroying the wheat. It was also received June 2 from Mr. J. G. Barlow, Cadet, Mo., who observed it to be very injurious to oats.

REPORTED INJURY DURING 1901.

During the spring of 1901 this species became extremely numerous in the grain belt of Texas, as the communications received during that year show.

Mr. W. R. Peters, Caddo Mills, Tex., wrote March 15: "I inclose you a sample of red winter wheat that has been killed by a small green bug. The wheat in our county is badly damaged by the insect. I have 50 acres destroyed by this bug." The same day specimens were also received from Mr. C. A. Kelsey, Sherman, Tex., who said: "These little flies are fast destroying the young wheat; they are beginning to sap the oats, and have been working on the grain since early fall."

Mr. H. K. Jones, Valley View, Tex., in a letter dated March 16, says:

I inclose you a sample of insects which are killing the young wheat in this section; they are on the wheat by the million. They first made their appearance about ten years ago, at which time they killed all the wheat, or about all, in this county, and what was left made only 1 to 3 bushels per acre. The next time we noticed them was last year, when they made their appearance early in spring. After the wheat headed they went to the heads, and we thought they would surely ruin the wheat, but we had a good yield; after the wheat headed we had a great deal of rain, which may account for it. We first noticed them this season in December last; they were not numerous, but have been increasing ever since. We find that cold does not hurt them; they have gone through a zero spell and come out all right; have seen the wheat covered with sleet and the bugs frozen up, but on thawing they seemed to be as hungry as ever. Wet weather is no drawback to them; we have just had a good rain a week ago, but the wheat looks worse and the bugs better.

Mr. J. C. Coit, Denton, Tex., wrote March 18 that wheat in his section was badly injured by this insect and that a few days previous it was noticed that the wheat did not have so deep a color as usual at that season. Upon an investigation it was found that the outer leaves of the wheat were dead. The aphides were found on the ground under the protection of the leaves, in some spots as many as six or eight around the same plant. In 1890 the wheat was destroyed by this or some similar pest.

In a communication from Mr. B. H. Hamilton, Weston, Tex., March 18, it was stated that this insect was ruining the wheat in that part of Texas, that it had been at work for six or eight days prior to the date of writing, and it was noticed that on striking a bunch of wheat the ground would be covered with numbers of the insects. It was in that vicinity this year (1902), but did not appear until the last of April or first of May.

March 26 Mr. F. C. Ratcliff, Vernon, Wilbarger County, Tex., reported that this louse infested the wheat fields, and that the crop in some parts of that county was suffering from its depredations.

March 27 Mr. Oswald Wilson observed this species on wheat near Houston, Tex., and on the 10th of April near McKinney, Tex.

March 29 Mr. D. M. Hamilton, Austin, Tex., reported that these plant-lice were worse on stubble land of wheat than on corn or cotton land.

On the 1st of April specimens were received from Mr. J. Booze, Sherman, Tex., who stated that "these flies or gnats" were very numerous in low places and that they had entirely destroyed the oats and wheat.

Under date of April 22 Mr. A. E. Jenks, of the American Thresherman, Madison, Wis., forwarded to this office specimens of this insect received from Elmont, Grayson County, Tex., with the report that wheat, oats, and corn were all ruined by it, and that during the year or two previous it had done great injury to these crops in Texas. On the same date the following note was received from Mr. S. E. Russell, Fate, Tex.: "I send you herewith a few of the little green bugs which are destroying our crops in toto. Wheat and oats are gone; there are not so many on corn to-day."

Specimens were also received April 24 from Ralli Brothers, New York City, which they had obtained from their Greenville, north Texas, cotton agency, with the accompanying report:

This insect has seriously injured wheat and oats and is now attacking young corn. Wherever they have attacked wheat or oats the field looks as though it had been swept by fire. A number of farmers have been forced to plow up their wheat and plant corn.

A letter was received April 25 from Mr. J. W. Bussell through the American Thresherman, complaining of injuries by this insect at Mountain Peak, Tex., saying that it was playing havoc with the grain crop there; oats were entirely ruined, and wheat cut 50 per cent.

April 30 specimens were received from Mr. J. C. Crispin, Saratoga, McDonald County, Mo., with report that this insect was very numerous on wheat, and that some fields might have to be plowed up.

In a communication of May 14, Mr. W. E. Campbell, of Ralli Brothers Agency, Greenville, Tex., stated that a few days previous to writing the weather became quite warm, causing the insects to leave that section and go farther north. They appeared to be better suited to cold, damp weather. A number of fields in that vicinity were visited where the insects had been particularly troublesome, without finding a specimen at that time, the warmer weather having apparently driven them completely out of the country.

NEWSPAPER REFERENCES TO INJURIOUS OCCURRENCES IN 1901.

Numerous clippings were received from newspapers relative to the spread of this grain louse and destruction wrought by it to small grain crops in Texas and adjoining territory during the spring of 1901. The following are transcribed:

[Galveston News, March 21.]

Denton, Tex., March 18.—W. E. Smoot, of Argyle, was here to-day with a quantity of the little green insects that are doing so much damage to the wheat. The insects are present in myriads and the big wheat farmers are taking a very gloomy view of the prospect, many of them believing that their crops are irreparably ruined. Many of them, in fact, are making preparations to plant the injured wheat land in cotton or corn.

Farmers who were here ten years ago say that the present visitation is exactly like that of 1891 and that the entire wheat crop of several counties was almost entirely lost, some of the yield being as low as half a bushel to the acre and the highest not more than 10 bushels.

Gainesville, Tex., March 12.—Dr. W. H. Freeman, who lives at Era, 15 miles west of Gainesville, in speaking of the growing wheat, said: "The wheat in my section is literally ruined, and the farmers will have to plow it up and plant the ground in corn and other products."

Sherman, Tex., March 18.—The condition of the wheat crop from the inroads of the Hessian fly or some similar pest is attracting much attention. In some localities it is said that the wheat crop will be plowed up and cotton or some other late crop planted instead.

[Dallas (Tex.) Herald, March 21.]

Sherman, Tex., March 21.—Great alarm is felt here by the farmers at the ravages of a small green bug that is infesting the wheat and oats.

[Dallas (Tex.) Herald, March 22.]

W. H. Marshall, a prominent farmer of Whitesboro, Grayson County, said: "The reports about the damage being done to the wheat in our part of the State are not exaggerated in the least. Hundreds of acres have been killed around Whitesboro and in other parts of Grayson County. The flies have also gotten into Collin County and are doing considerable damage there, and some damage has been done in Denton County. Unless the ravages are checked soon we will have to buy our flour and seed wheat."

[St. Louis (Mo.) Republic, March 24.]

Reports from Texas say that at least 25 per cent of the wheat crop in the northern part of the State has been ruined by the bug, and the entire crop is threatened.

The insects are seen in countless numbers in the growing wheat. Advices from all parts of Texas say that the pest is spreading, but appears to be working only the stubble-ground wheat.

Owing to the mildness of the winter, instead of being killed it propagated rapidly, and apprehensions are felt for the entire crop. So far wheat on the cotton ground does not appear to be damaged.

[Galveston (Tex.) News, March 26.]

Waxahachie, Tex., March 26.—Mr. B. F. Cherry, of Midlothian, this county, reported that a little green bug was doing a great deal of damage to wheat in that

section of the county and that some of the wheat fields near there had been almost entirely destroyed by the insect.

Hutchins, Tex., March 26.—Mr. A. W. Carnes writes to the News that he has just returned from an examination of the wheat and oat fields upon the county farm, and finds that the entire oat crop—30 acres—and 15 acres in a wheat crop of 75 acres, have been entirely destroyed. The bugs are still working upon the wheat, marching from east to west, maintaining a straight line from north to south, as though they were under the leadership of a trained tactician.

Ennis, Tex., March 26.—Mr. E. D. Champion, a farmer of Oak Grove, said to a News correspondent that wheat in his community has been suffering from an insect pest, though it is coming out well since the recent rains.

[Houston (Tex.) Post, March 29.]

Sherman, Tex., March 28.—Holmes Colbert, one of the prominent Indian planters of the Choctaw Nation, was in the city to-day. Colbert has 4,000 acres in wheat and oats, and says the pest has appeared in the Indian Territory.

[Fort Worth (Tex.) Register, March 31.]

J. C. Martin, who lives at Riverside and has recently been in the northern part of the county, says that the damage there is not as great as recorded, although there are many spots perfectly bare.

D. M. Morgan, of the cotton belt, says the crop is ruined between that place and Sulphur Springs, and between Dallas and Sherman, and also between this city and Thurber. Mr. Morgan says he has saved his own crop by cultivation with a weeder.

Milt Hampton, who was in from near Crowley yesterday, said that his crop of 200 acres was so badly damaged that he turned his cattle in on it and will plow up the ground and plant cotton and some other crop.

John Day, who was in from his farm in the northern part of the county, said that he had not suffered much, but some of the crops in that portion of the county were ruined.

T. N. Bradburn returned Friday night from a week's trip up the Fort Worth and Denver road, stopping at nearly all the stations between here and Iowa Park. He says that up to a week ago the Panhandle had the finest prospects for a great wheat crop, but now the wheat has been greatly injured and in some places entirely ruined. The bugs reached Wichita Falls on Tuesday last and now there are millions of them laying waste the crops. Many fields, he says, between here and there are ruined.

[Dallas (Tex.) News, April 2.]

Denison, Tex., April 1.—W. B. Chiles, a prominent farmer living near Pottsboro, states that the grain-destroying insect is doing great damage in his section of the country. They fly about late in the afternoon. At times the air is full of them and they travel with the wind. They are now working especially on oats.

J. W. Badgett, who lives east of Colbert, Chickasaw Nation, said: "I stated last week that we had no signs of the insect, but the case has been reversed; this week we have them, and by the thousands. They seem to be concentrating on oats, but I believe that unless steps of precaution are taken, they will kill our corn before it is old enough to escape them. I have been farming a long time, but I have never seen anything like this work on grain. I am going to make an experiment Monday. I will run a harrow over my grain and then roll it with a heavy log. This will kill the insects and even if our oats are killed by the remedy, we will thereby save our corn.

[Dallas (Tex.) Herald, April 11.]

Rhome, Tex., April.—The ravages of wheat and oats insects are causing great depression of spirits among the farmers of this county. A large part of the wheat acreage

is completely ruined by the insects, while other portions are scarcely touched. Much of the wheat will be plowed up and cotton planted.

[Galveston News, April 17.]

Ennis, Tex., April 15.—Mr. George Hoggs, of Telico, said to-day that myriads of green bugs fell upon his corn yesterday and covered it up, and he will begin to-morrow to plant June corn between the rows.

[Dallas (Tex.) News, April 17.]

Kingston, Tex., April 15.—The ravages of the green bug have almost destroyed the oat crop in this vicinity. The wheat crop is improving and looking better; it seems to be outgrowing the injuries of the bug. Yesterday it was warm and the bugs seemed to be on the move south. The air was thick with them during the entire day and some farmers report them leaving their fields.

Fate, Tex., April 15.—Large fields of the spring oats have been entirely destroyed by the little green bugs. Winter oats and wheat have not fared better, but can hold out longer on account of being better rooted. It was thought that the little pest would not bother the corn, but all corn is badly damaged and some fields look as if they would have to be planted over.

[Nevada (Tex.) News, April 19.]

We have interviewed several farmers this week from different parts of the county relative to the work of destruction that has been done to the small grain crop. The majority of them say that the oat crop will be a total failure and that the wheat crop at the outside will be cut short 50 per cent. The farmers say that where corn has come up that it is being attacked by the pest and will no doubt be ruined. Some few have begun to plant their corn over.

[Dallas (Tex.) Herald, April 23.]

McKinney, Tex., April 23.—The green bugs filled the air yesterday, making their exodus, leaving behind them hundreds of acres of blighted wheat and oats.

[San Antonio (Tex.) Express, April 23.]

Sherman, Tex., April 23.—Farmers from various sections of the country who were in Sherman to-day stated that green lice are still swarming. They seem to be leaving the corn, to the great satisfaction of the farmers.

[Galveston (Tex.) News, April 24.]

Fort Worth, Tex., April 23.—The executive committee of the Millers' Association held a meeting here this afternoon, and the greater portion of the time was consumed in hearing reports of the damage done to the wheat crop by the green bugs.

Henry Landa, a member of the committee, from New Braunfels, said that the damage to the large wheat counties would reach 75 per cent; and that, in Grayson, Cook, and Denton counties especially, it was reported the farmers would not make seed, and would not, in a number of the larger wheat counties, get back as much wheat as they had put in the ground. Mr. Landa thinks the situation is very unfavorable for the millers, as some will not be able to run their mills, and others will have to go out of the State to get their grain.

[Dallas (Tex.) News, April 24.]

Persons who were on the streets in certain portions of this city were vexed by the countless numbers of little bugs that clung to their clothing so tenaciously that it was almost impossible to brush them off. In some places they were so numerous as to present the appearance of an Indian summer haze.

These were the famous green bugs or plant-lice, whose ravages in this section this year have cost the farmers many and many a dollar. They were all northward bound, their departure from the grain fields being caused doubtless by the warm weather now prevailing.

Of the number that took wing for cooler regions there are probably several billions that will never raid another grain field. The English sparrows—the pest of the city—began at daybreak a war of extermination upon the pests that ended only at twilight. Twittering with delight, they sailed in flocks through the clouds of bugs, devouring all they could hold. These attacks, however, caused no perceptible diminution in numbers.

An instance of the loss caused by the lice was reported here during the day. A Dallas County tenant farmer had many acres in wheat and oats which these bugs completely destroyed.

[Houston (Tex.) Post, April 25.]

Cleburne, Tex., April 22.—The green bug is killing oats north of the city and has devastated several fields in this neighborhood.

[Dallas (Tex.) News, April 25.]

McKinney, Tex., April 24.—The News correspondent traveled over the county from McKinney to the Shain ranch beyond Celina, a distance of 22 miles; thence south along the Denton and Collin County line to the ranch of Parvin, 18 miles west of McKinney; thence east of McKinney yesterday. The devastated wheat and oat fields presented a fall-like appearance, owing to the brown color so much like stubble land. Thousands of acres will be idle this year for want of labor to replant. It is a scene of desolation in every direction in west Collin.

Denison, Tex., April 24.—James Jacobs, a farmer from the country a few miles west, says the bugs are still active and seem to breed as long as there is anything green to feed upon. He has noticed, however, that the sun kills them as quickly as their wings grow.

Sherman, Tex., April 25.—Statements from authentic sources that the green bugs are leaving in great swarms continue to come in from all sides.

[St. Louis (Mo.) Republic, April 26.]

Kansas City, Mo., April 24.—Grain men who are going over the wheat fields of Oklahoma say there is a genuine alarm entertained because of an invasion of the green bugs.

Henry Lason, of El Reno, and C. H. Stevens, of the Purcell mill, report the louse as making inroads in the summer wheat to the extent of threatening to destroy a vast acreage. The Government report shows last week the louse was confined south of Guthrie, but now it is reported nearing the Kansas line. The winter hard wheat is not attacked. Cold weather has no effect. In places the entire space in the fields attacked is absolutely dead, though wheat is knee-high.

[Fredericksburg (Tex.) Star, April 27.]

The wheat fields of Meridian have a new and destructive enemy. The farmers are very anxious about them. They fear that the wheat crop will be utterly destroyed by them. Some crops are reported as already destroyed, and the owners are thinking of plowing up the fields and planting them in corn.

The oldest inhabitants have never seen anything like them. They are about the size and shape of the mites which are sometimes seen on cabbage-stalk sprouts in the spring, but their color is a deep dark green, about the shade of the green blade on which they feed, and sometimes 6 to 8 will be found on a blade. In a few days the blade turns yellow and begins to dry up. They also abound on the winter oats.

[Galveston (Tex.) News, May 18.]

Sherman, Tex., May 17.—J. P. Harrison, president of the Texas Grain Dealers' Association, in reviewing the grain crop, said to the News reporter: "There will be no oats raised in Texas north of Waco. In Coryell and adjacent counties the reports are not quite so discouraging, and it may be that sections may produce enough to supply Texas with seed. The condition in Texas is duplicated in the Indian Territory, where the situation can be attributed directly to the green bugs. In Oklahoma the bugs did not do much damage. But for drought, which came and finished their work, Oklahoma might have had a pretty fair crop. There will be little or no wheat made. Occasionally a field is heard from that will harvest a fair yield. I can only account for it on the theory that the fields were a little forward and the stalks tough enough to withstand the bug."

[Galveston (Tex.) News, May 30.]

The small grain crop of the State will not exceed one-fourth of last year's yield. The average in wheat and oats is less and the conditions 75 per cent below the average of May, 1900. The yield is cut short owing to the early spring drought and to the ravages of the aphid or green bug. The damage by the pest, although amounting to total losses in many fields in choice grain counties, is slight compared with general damage due to want of moisture early in the growing season. The reports annexed cover 161 counties, 105 of which were free of the insect pest, while all the counties reported suffered for the want of moisture.

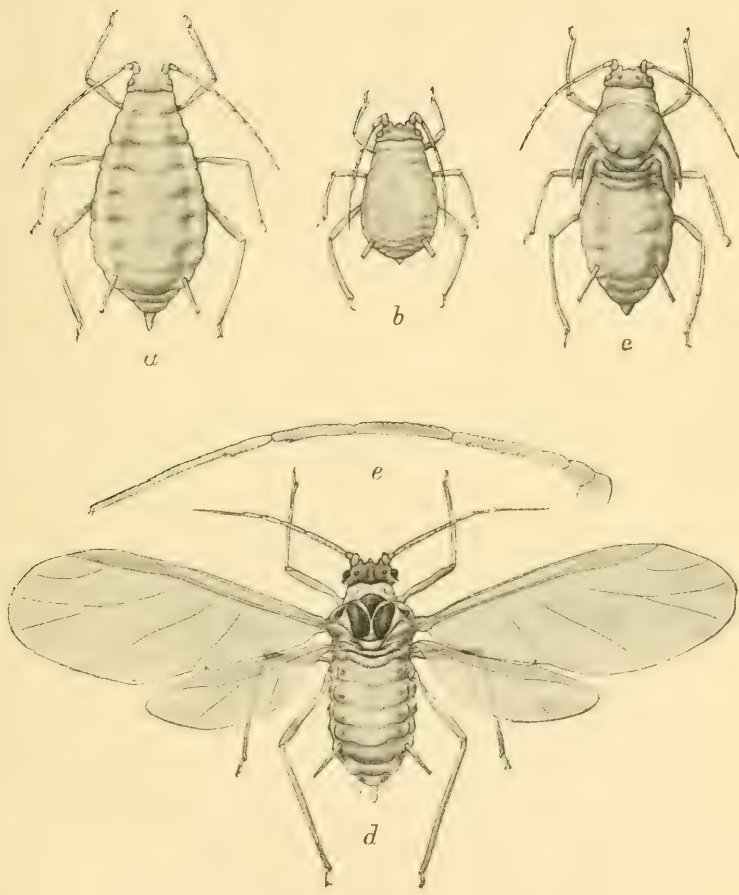
The pests appeared in numbers early in April, multiplied rapidly, were rapacious of appetite, and gluttonous without apparent satiation, repletion, or surfeit, and began to disappear in flurries in May. When the bugs attained the aerial stage they rose in a body from the ravaged field, took flight, remained on the wing for hours, and drifted with the wind. During storms they sought safety near the base of the wheat or oat blades. The farms intervening between the points of ascent and descent sustained no insect damage, but suffered from drought. The drought preceded the advent of the aphid, the 40 counties reporting "green bugs" also chronicling an early spring drought. The percentage of losses where not separately given combine the damage from both causes.

The wheat crop in the Chickasaw and Cherokee and portions of the other three nations in the Indian Territory, and in Oklahoma, ravaged by the grain louse, has greatly reduced the value of this year's crop in those Territories. In some regions the injury has been so great that farmers have preferred to replant the wheat acreage to some other crop. The louse, like its relative in Texas, is capable of very rapid multiplication, is gluttonous in appetite, and is favored by dry weather. The general trend of the migration of the insect, as in Texas, was from south to north.

GENERAL REMARKS.

In view of the overwhelming evidence as to the destructiveness of this pest to wheat and oats in the grain-producing States, it seems strange that it should have escaped notice until the year 1884.

Whether this plant-louse is indigenous to this country or whether it has been introduced from abroad is a difficult question to answer. At any rate, according to the notes of the Department of Agriculture, it was first observed in the more central section of States bordering the Atlantic Ocean, which seems to indicate that in some way it managed to reach our shores on a vessel from the southern part of Europe, entering one or the other of the ports of this central section, from



THE SOUTHERN GRAIN LOUSE (*TOXOPTERA GRAMINUM*).

a, Apterous female; *b*, larva; *c*, pupa; *d*, winged migrant; *e*, antenna of migrant—all enlarged (original).

which it managed to spread and to establish small colonies here and there on various grasses, suited to its taste, which insured it a foothold in this country and enabled it to multiply without being detected in time to adopt heroic measures for its extermination. The assumption of its foreign origin seems the more reasonable since otherwise its presence on small grain would have been observed from the earliest time that these cereals were grown in this country.

After its introduction it has naturally migrated in various directions, and established small, isolated colonies which have given it a chance to obtain a foothold and to escape observation and detection. From these centers of infection and with the assistance of air currents it would be enabled to spread unobserved to far distant sections until it reached grain-producing areas, the tender and succulent plants of which are more suited to its taste. Thus it has multiplied rapidly and spread from field to field and from State to State. Notwithstanding that millions of the migrants are killed during this flight, enough remain to stock new regions.

At the time of migration, which in the Southern States, as far as observed, takes place in May, most of the wheat and oats which escaped injury had become so tall and vigorous as to withstand attack. Possibly such growth may be unfit for the sustenance of this plant louse.

Whether the species really thrives on corn or not is an open question. Thus far it has never been received by this Department from any of the corn-growing sections. The writer is rather of the opinion that the plant-louse frequently observed on corn is the common corn aphid, *Aphis maidis* Fitch, which somewhat resembles this grain louse both in size and general coloration.

What becomes of the survivors after leaving the grain remains an unsolved problem. It seems, however, quite natural that during the warmer season, after the harvesting of the grain, they will subsist upon various succulent grasses growing in damp and moist localities, such as the borders of rivers, creeks, swamps, or similar places, and perhaps also on volunteer wheat and oats coming up in the fields. These would afford them a chance to survive and multiply until the new grain makes its appearance above ground.

As with other aphides, a sexual generation will appear at the proper time, and with it the eggs, for the preservation of the species. The great majority of our indigenous species of plant-lice produce the sexual generation during the fall of the year, the eggs of which remain dormant till the time at which a new cycle of plant life appears. A few, however, produce the sexes and their eggs during the latter part of spring or early summer, to hatch the following spring. What are the habits of this grain aphid in this respect it is difficult to say. Taking into consideration the very early appearance of the lice in

perceptible numbers on young grain, it appears probable that one or another generation, descendants of the migrants from grain, produces a sexual generation and consequent eggs on some kind of grass, which may hatch during the fall of the same year instead of the following spring, in time to produce a winged generation. This last probably re-migrates to young winter wheat, to restock it with lice, and many would undoubtedly perish during the cold and wet season, though enough of them would survive to reproduce when the climatic conditions become more favorable.

The whereabouts of the species after leaving the grain, the hiding place of the sexes and their eggs, and the reappearance on grain, are highly interesting and important questions, which entomologists of infected sections should strive to solve for the benefit of those engaged in the cultivation of small grain.

DESCRIPTION OF THE SPECIES.

Apterous female.—Length 1–1.8^{mm}; color yellowish green and slightly pruinous, the median line darker green, the head and prothorax somewhat paler than the rest of the body. Eyes black. Antennæ black, the two basal joints and more or less of the third joint at base yellowish. Legs yellowish, the tibiæ brownish toward the apex, tarsi black; nectaries greenish and frequently with a dusky tinge, their apex black. Tail dusky. The general color of the larvæ and pupæ is like that of the apterous female. Wing pads of pupa dusky to black. Antennæ slender and about one-half the length of the body. Nectaries slightly tapering, reaching to or slightly beyond the end of the body. Tail slender, somewhat constricted about the middle, and about two-thirds the length of the nectaries. There is a distinct fleshy tubercle each side of the prothorax and similar tubercles along both sides of the abdomen.

Migratory female.—Expanse of wings 5–7^{mm}; length of body 1.5–2^{mm}. General coloration of the abdomen as in the apterous forms; head brownish yellow; the eyes brown; antennæ, thoracic lobes, the posterior margin of the scutellum and the sternal plate black; the two basal joints of the antennæ yellowish green; legs yellow, the femora more or less dusky, the posterior pair darkest; apex of tibiæ and the tarsi black; nectaries and tail yellowish, the latter changing gradually to dusky or black toward the end; wings transparent; costa and subcosta yellow; the stigma somewhat paler, its inner edge and the veins black. Third discoidal vein with but one fork. Antennæ long and slender, reaching nearly to the end of the body, the third joint provided with 3 to 7 sensoria. Nectaries, tail, and lateral tubercles, as in the apterous females. (See Pl. I.)

NATURAL ENEMIES.

As natural enemies of this species in Europe, Rondani mentions *Scymnus 4-pustulatus* Fab., a small Coccinellid or ladybird, the adult and larvæ of which feed upon the lice; *Paragus cotulnatus* Rondani, a two-winged Syrphid fly, whose larva preys extensively upon all kinds of plant-lice; and a minute hymenopterous insect, *Aphidius aphidum* L., a true internal parasite.

Of the most effective predaceous insects which have been observed to feed upon this grain Aphidid in the infested regions of the United States, the following may be mentioned: Two ladybirds, *Hippodamia*

convergens Guér., and *Coccinella 9-notata* Hbst., both of which, in the adult as well as in the larval state, feed ravenously on the lice, though the larvæ are frequently suspected by grain growers of being the parents of the lice, especially if found to be numerous in infested fields; and larvæ of various Syrphid flies and Chrysopids or lacewing flies, which are even more voracious than those of the Coccinellids.

Many of the lice are also killed by the larvæ of a small and slender black internal parasite, *Lysiphlebus tritici* Ashm., which preys upon various species of plant-lice, frequently killing large colonies within a short time. The larva of this species does not leave its host, but transforms within the puffed up and empty shells of the aphides, many of which may readily be observed adhering tightly to the stems or blades of the grain. The little parasite, when ready to leave its host, cuts out a neat circular piece, generally near the end of the body, and escapes through the opening.

METHODS OF CONTROL.

Owing to the practical impossibility of applying kerosene emulsion or similar washes so as to destroy insects which develop on standing grain, particularly such as feed by suction, we must look to other methods for the successful treatment of this plant-louse. Three or four other forms of plant-lice usually occur in more abundance than the species under discussion, and it has been found by experience that these, as well as the present species, are very largely controlled by natural conditions, sudden changes in the atmosphere, and such parasitic and other natural enemies as have just been considered. Lady-birds and fungus diseases are the most important factors in reducing the numbers of this pest. The year 1901 was particularly favorable for the multiplication of this plant-louse in Texas, but, as usually happens, the cool, moist weather of early spring, which favored the increase of the pest, was followed later in the season by a sufficient period of dry and sunny weather to enable the natural enemies, nearly all of which are most active in such weather, to gain the ascendancy, and this they did, practically exterminating the lice in the region affected. It should only be necessary to add that most other species of plant-lice are controlled in precisely the same manner, and it is seldom that they are destructive for more than one or two seasons in succession. Examples are to be found in the cabbage louse, melon louse, and the destructive green pea louse, which was such an enemy to the pea industry throughout the more northern portion of our country during the years 1899 and 1900, from the Atlantic coast to Wisconsin. This last insect practically disappeared as a pest during 1901, and up to the date of writing has only appeared in numbers in a few isolated localities, so far as we know, in the District of Columbia and immediate vicinity.

REPORT OF AN INVESTIGATION OF DISEASED COCOANUT PALMS IN CUBA.

By AUGUST BUSCK.

In August, 1901, I was instructed to proceed to Habana, Cuba, and report to the military governor there in order to investigate a disease which threatened the cocoanut industry in the province of Santiago.

In accordance with instructions, I left Washington August 7 and, arriving in Havana on the 10th, reported in the palacio to the adjutant-general, Col. J. H. Scott. The same day I sailed with his instructions for Baracoa, on the northeast corner of the island, arriving there August 14. The country around Baracoa is the only remaining cocoanut region of importance in Cuba, and the industry is the main support of that part of the island, from which large shipments of great value are annually exported to the United States.

The country of that region is mountainous, rough, very fertile, and picturesque with palm-covered mountain sides, deep valleys, and large rivers. There are no wagon roads, and travel is on horseback along narrow and often difficult trails.

There were no diseased palms in the immediate neighborhood of Baracoa, but going out some 10 miles east along the coast, yellow, drooping tops and naked trunks began to appear, and still farther out around Mata and neighboring towns the disease reached its highest development. Here large areas were attacked, and already from 10 to nearly 100 per cent of the trees were lost. Serious damage was quite evident, and the lamentations of the natives and their anxious inquiries as to how to save their sole property were most natural.

The first outward indication that a palm is attacked is the falling of the young fruit; shortly afterwards the larger nuts drop and the leaves assume a pale yellowish color.

Within a month all the large lower leaves droop and fall, leaving the pale, sickly tops, which at the first heavy wind blow over and then only the naked trunks stand as ghastly tombstones where a few months before stood graceful valuable palms. Palms of all ages are subject to this disease, though it seems more prevalent among the older plants.

On felling a palm and examining it, it is apparent that the trouble is not found in the root or main part of the small trunk. From the root upward to within a few inches from the top, the trunk may be fresh and sound with practically no insect of any kind and with no fungus mycelium. Just below the top and in between the bases of the leaves were found, in nearly all of the three hundred odd palms in different stages of disease which were cut down during my investigation, the galleries of Scolytids or ambrosia beetles (*Xyleborus* spp.), rarely, however, in such numbers as to arouse suspicion of the beetles being the cause of the death of the palms.

In and around these holes and perforating the entire upper part of the trunk for 2 to 10 inches downward was found the mycelium of a fungus, the fruiting bodies of which came forth as small white spots on the under side of the leaves and which might easily, on hasty examination, be confounded with *Aspidiotus* scales which were often found there.

This parasitic fungus has been identified by Mrs. F. W. Patterson, mycologist, and Mr. A. F. Woods, pathologist, of the Department of Agriculture, as *Pestalozzia palmarum* Cooke. They inform me that though they have no record of the particular damage, "it is extremely probable that this fungus is the cause of the diseased condition of the trees," as they have records of similar causes in other trees.

Breaking off the lower leaves and cutting the center of the green growing part open, the heart of the palm is, found to be one putrid offensively smelling mass, filled with maggots of various scavenger flies. By examining palms in various stages of sickness, it was found that the putrefaction began within the sheath around the young, still unfolded flower stalks and gradually worked downward to the center of the plant, and while the primary cause of the death of the palm undoubtedly is the fungus, the nature and foul smell of the diseased parts seemed to indicate some bacteriological influence, when the palm is already weakened by the fungus and doomed to die.

In from one to three months after first attack full destruction takes place and the trunk stands naked; and though it is still fresh and apparently sound, it soon disintegrates through the work of termites or white ants and other insects.

The fatal nature of the disease precludes a remedy for trees already infected and leaves only the prevention of the spread of the disease as the object for man's intervention.

As the most natural means of preventing the spread of the disease, the cutting down and burning up of the diseased palms suggests itself, and Mr. A. F. Woods agrees that this is one of the best ways of combating it. In a small and necessarily incomplete way I satisfied myself of the practical results of this preventive. Shortly after my arrival I observed one large grove with only two isolated dying palms. These I had cut down at once and removed the infested parts to my headquarters for examination. During my entire stay no more palms in that grove showed signs of disease, although in other tracts with sick palms left standing new cases of infestation were observed in numbers every week.

The procedure of felling and burning many palms may seem too enormous an undertaking, but considering the interests at stake it is a small matter and comparatively easy of execution.

Without such drastic measures the present conditions and the rapid spreading of the disease certainly foreshadow total destruction of the

cocoanut industry, a very serious matter for the population of that part of the island of Cuba.

It is not necessary to burn the entire trunk, which would involve extra labor, but only the top with a couple of feet of the upper end of the trunk.

But it is necessary to have united action in order to make the remedy of any real value, as it is evidently futile for the proprietor of one estate to eradicate the disease within its limits if the owners of neighboring estates omit the precautions and allow the disease to multiply and send its spores abroad to the others. I therefore suggest local legislation, which would make it compulsory on every owner to cut down palms as soon as they show infection and have the diseased parts burned; and, furthermore, that some trustworthy, intelligent man be constituted inspector with the duty to inspect weekly the entire region and with power to have cut down at once and burned at owner's expense any sick palm found omitted.

Such action, together with advice to plant new cocoanut palms, will, I fully believe, save the greater part of this important industry, which otherwise seems doomed to annihilation.

The insects found to be connected with the cocoa palm in this Baracoa district were few and all of secondary or of no economic importance. The only ones which may form an exception are the Scolytids (*Xyleborus* spp.) through the holes of which the fungus doubtless gains easy entrance to the palms. These beetles are not always present and evidently do not constitute the only means for the spores to reach their destination. It is not impossible that they are altogether innocent and merely come after the weakened condition of the palm, as Mr. E. A. Schwarz suggests is probable. But as carriers of the spores from palm to palm these insects and numerous scavenger flies which are attracted to the sick palms may be of importance. The most common of these are the strikingly beautiful metallic-green *Volucella obesa* Fab. and the curious long-legged *Calobata nebulosa* Loew.

On the underside of the leaves and on the green fruit was found quite commonly, but never in dangerous numbers, the destructive scale insect, *Aspidiotus destructor*, which everywhere in that region was kept well in check by the black, red-spotted ladybird, *Chilocorus cacti* Linn.

A large beetle, *Stratægus titanus* Fab., was often found among the flowers of the cocoas and was invariably accused by the natives of being the cause of all the trouble, while in reality it did little or no harm in eating the pollen and possibly the tender shoots. The larva lives in decayed wood.

Of the palm weevil, *Rhynchophorus palmarum*, which before my trip was suspected as being the possible cause, not one was found and no other borer than the Scolytids previously mentioned.

The long double rows of egg-holes of the large *Cicada bicosta* Walk. were quite commonly found on the underside of the stalks of the lower leaves, but the damage is insignificant.

THE PALM AND PALMETTO WEEVILS.

By F. H. CHITTENDEN.

As in a measure supplementary to the report of an investigation conducted by Mr. August Busek, of this office, on diseased cocoanut palms in Cuba, due to the fungus *Pestalozzia palmarum* Cooke, but supposed to have been caused by the palm weevil (*Rhynchophorus palmarum* Linn.), the following account of that species and the palmetto weevil (*R. cruentatus* Fab.) has been prepared. It is somewhat singular that at the time Mr. Busek was prosecuting this investigation the palm weevil was not once encountered, but the palmetto weevil was doing injury to the date palm in Florida. The latter, although well known, has not attained any prominence as a pest, but we have an extensive account of the palm weevil by Mr. W. F. H. Blandford, published originally in the Kew Bulletin of February-March, 1893 (pp. 27-60).

THE PALM WEEVIL.

(*Rhynchophorus palmarum* Linn.)

With the establishment of the growing of cocoanut palms in British Honduras, the ravages of the palm weevil seriously discouraged that industry. In the year 1888 the government of that country, becoming cognizant that the losses apparently resulting from the palm weevil menaced the prosperity of the colony, appointed an investigating commission, the result being the publication of the article above cited. Until the injurious occurrence of this species in British Honduras, the palm weevil was better known to the public as the parent of the "gru-gru" worm, which was eaten by the natives of Central and South America, and mentioned by most writers of early times as "being considered a delicacy." On this head Mlle. Merian, in her "Dissertation sur la Génération et les Transformations des Insectes de Surinam," etc., published in 1726 (p. 48), wrote as follows:

The Dutch name it Palmyt-Worm, that is, the Worm of the Palm, because it feeds on that tree. In the trunk of the palm tree, swarm certain worms feeding on the pith. At first no larger than cheese-maggots, they grow like the one here represented. Certain folk grill them, and consider them a most savory morsel. From this worm comes a black beetle, such as I have depicted, which the Indians and the Dutch both call the *Mother* of the palm worm.

The next article of importance bearing upon this species is entitled "Insects infesting the Sugar-Cane." It was written by Rev. Lansdown Guilding, and published in 1828 (Trans. Soc. Encour. Arts. LXVI).

Through the kindness of Prof. M. E. Peck, Iowa Falls, Iowa, we have received some information relative to this same insect and its injuriousness to palms in British Honduras. Under date of January 1, 1902, he writes that during several months' stay there he became considerably interested in the cocoanut industry, and especially in the methods in use for meeting attacks of this palm weevil and other beetles infesting the cocoanut. Numerous plantations were reported to be seriously injured or wholly ruined by these insects, which are considered the chief drawback to the industry in that region. One grower, Mr. John T. Seay, of Manatee District, British Honduras, succeeded to some extent in conquering these pests. Mr. Seay had a plantation about 20 miles south of Belize and extending for 3 miles along the coast. His trees were in flourishing condition, ranging in age from two or three to fifteen years. Mr. Peck examined the larger part of the adult trees and found that nearly half of those with trunks over 6 feet in height had been attacked by the weevils, but had been successfully treated and the insects destroyed. Mr. Seay's method of treatment was described as so easy and rapid that one man could attend to many thousands of trees at very slight expense. He stated that if these beetles were as destructive in our newly acquired tropical territory (according to present accounts they are not) as they are in Central America, it would certainly be worth while for the Department of Agriculture to inquire into the matter.

Mr. Seay was written in regard to his experiences, and he answered January 22, and later in 1902, giving much information concerning this and other insects associated with injury to palms cultivated in British Honduras. His acquaintance with this weevil dated back about thirty years, and for half of that time he had been studying its habits in order to be able to use his knowledge to advantage in the application of remedies.

ASSOCIATES OF THE PALM WEEVIL.

The associates of this weevil, specimens of which accompanied other material, were a large shining black Histerid beetle (*Hololepta quadridentata* Say), a large dipterous larva or maggot, which proved on rearing to be *Willistonella pleuropunctata* Wied., also *Epiplatia crosa* Loew both the young of Ortalid flies and two forms of mites identified by Mr. N. Banks as belonging to the genera *Uropoda* and *Holostaspis*. The latter mite was observed singly, in the material furnished us, on both the weevil and the Histerid, sheltering in clusters on the hairy portions of the under surface of the weevil and more especially on the tibiae, although also clustered on the abdomen and prosternum. There is no doubt that these mites are of some value in destroying the weevils in their different stages, more particularly, perhaps, when in the pupal stage, if they have opportunity to penetrate

the pupal cells. Histerids are, as a rule, predaceous, at least in the larval stage, and these may also do some good by destroying the eggs and young of the weevil when the latter are first hatched.

Rhina barbirostris Fab.—June 19, 1902, we received from Mr. Seay, through Mr. E. J. F. Campbell, superintendent of agriculture, botanic station, Belize, Honduras, specimens of this large weevil, with the expression of opinion that, first of all, the cocoanut trees were in a more or less unhealthy state when attacked by it and that it did no harm to healthy trees; but, to attract the insect, some injury must in the first instance happen to some part of the plant, stem, roots, or leaf, to cause a flow and subsequent fermentation of sap.

The *Ambrosia* beetles (*Xyleborus* and *Monarthrum* spp.) bore into the cracks of the stem of the injured plants; and the palm weevil (*Rhynchophorus palmarum*) follows. The ambrosia beetles make holes in the trunk and bore straight ahead, the size of the holes never increasing, and throw out sawdust, which the weevil does not usually do. The latter makes a small hole and inserts an egg which hatches into a grub, and the grub excavates cavities which constantly increase in size, until finally it forms its cocoon.

AS TO WHETHER INSECTS ATTACK HEALTHY OR ONLY SICKLY TREES.

The belief is quite prevalent in British Honduras that the palm weevil is the chief cause of the great damage to cocoanut trees in that colony. Mr. Seay is of the opinion that the ambrosia beetles are more responsible as conveyers of disease than the palm weevil. Mr. Campbell states that the disease locally known as "fever," presumably due to the fungus *Postaloizia palmarum*, or a similar species, is the sole forerunner of the trouble. He supposes it to be conveyed from unhealthy trees growing in unsuitable ground. On this head he expresses himself substantially as follows:

From my own observation I am of the opinion that cocoanut trees are never attacked by weevils unless the plant is more or less in a sickly condition—a fever of some kind. This fever may originate from different circumstances, such as sudden cold weather, excessive wet, causing water to lie around and affect the roots, the want of good drainage, inferior soil, sudden exposure of the stem to the direct rays of the sun, or other conditions due to planters neglecting to clean their trees for months or years. * * *

He is convinced that "no fly, bug, or weevil" will attack a perfectly healthy cocoanut tree that receives proper attention by its owner.

THE PALMETTO WEEVIL.

(*Rhynchophorus cruentatus* Fab.)

September 10, 1901, we received specimens of this species in the grub state from Mr. Lee Mulford, Fort Ogden, Fla., that had been taken from a 10-year-old seedling date. The entire trunk was found

to be honeycombed, and fifty or more of the grubs were observed. They were stated to be quite active and capable of traveling some little distance, and to be noisy when at work, making a sound like the escape of water with an occasional screech like a choked hen.

April 4, 1902, Mr. W. F. Fiske, Atlanta, Ga., sent fragments of this beetle, taken from its cocoon in the trunk of *Sabal palmetto*, the tree having died and the crown fallen. Other trees in the neighborhood were killed and some showed evidence of attack.

DESCRIPTIVE.

The beetle.—The general appearance of the beetle is shown in figure 1, at *a*. The thorax, and frequently the elytra, are usually more or less reddish; sometimes both are decidedly red, marked with black spots which form a pattern more or less like that depicted. The under surface is also partly red and partly black, but frequently specimens are met with which are entirely black, some decidedly polished, and

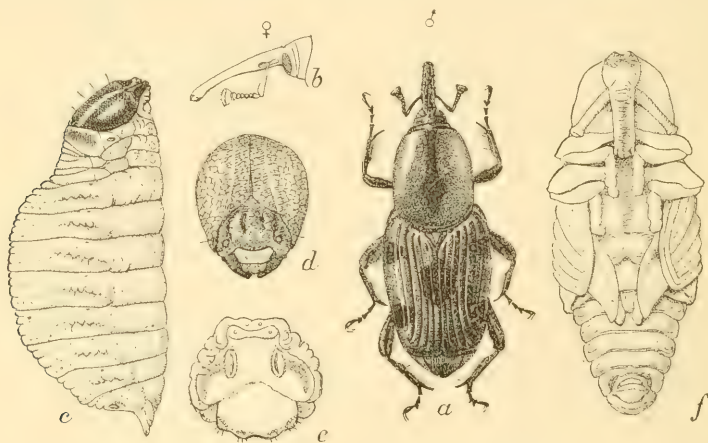


FIG. 1.—Palmetto weevil (*Rhynchophorus cruentatus*): *a*, male beetle; *b*, head and appendages of female from side; *c*, larva; *d*, head of same; *e*, last ventral segment seen from above; *f*, pupa—*a*, *c*, *f*, slightly enlarged; *b*, *d*, *e*, more enlarged (original).

others dull and velvety. The body above is depressed and, as with other weevils, the head is prolonged into a snout, which is comparatively short and very rough in the male, while in the female it is longer and more slender and almost perfectly smooth along the upper surface. (Compare *a* and *b*, fig. 1, the latter a side view of the female head with snout and antenna.) The antennae are geniculate or elbowed, as in most curculios of this group, and the last joint is strongly expanded. The elytra, or wing-covers, are deeply striate or furrowed, as shown in the figure. The legs are fringed on the inner surface with long reddish-yellow hairs, and the tip of the tibia bears a long apical spur and two shorter teeth. The length, exclusive of the snout, measures from eight-tenths of an inch to upward of an inch and an eighth. A technical description is furnished on page 408 of Dr. Horn's paper entitled "Contributions to a knowledge of the Curculionidae of the United States." (Proceedings American Philosophical Society, 1873.)

The larva is shown in figure 1, at *c*. It very closely resembles that of *R. palmarum*, which is figured in both the articles of Messrs. Guilding and Blandford. It is of robust form and somewhat different from any other rhynchophorous larva that has

ever been under observation by the writer. Its color is rather pale yellowish-brown, with exceptions of the first thoracic segment, which is chitinous, and the head, which is dark brown. The latter is illustrated at *c* (fig. 1). A large proportion of the head is divided into irregular reticulated areas, giving the appearance of very large eyes. As will be seen in the illustration, the segments are quite distinct, and there are 9 spiracles, including 8 abdominal ones. The length, when in somewhat retracted position, is about $1\frac{1}{4}$ inches. In many respects this species resembles that of *R. palmorum*; hence a detailed description is scarcely necessary, as nearly two pages have been devoted to the description of that species in Blandford's article previously quoted. It should be stated, however, that Horn, quoting LeConte as authority, says that these stigmata are completely absent, because neither of these specialists had an opportunity of observing fresh alcoholic specimens, and drew their deductions from "a carefully prepared skin."

The pupa (fig. 1, *f*), in specimens which the writer has had under observation, is of a similar color to the larva, and is noticeably larger than the beetle, a rather unusual matter with pupæ, but readily accounted for because the pupa is necessarily rather delicate, while the beetle is decidedly hard like all of its kind and quite compact. The length of four pupæ before the writer afford an average of $1\frac{3}{8}$ inches. This species appears to be most abundant in Florida, but is recorded as occurring from South Carolina to Louisiana.

REMEDIAL TREATMENT.

Owing to the somewhat peculiar habits of these weevils and their resistance to poison, we can not treat them by any single method, but must employ several, both cultural and mechanical. Perhaps one of the best preventives that has been suggested consists in cutting down or wounding several young trees or wild species of palm or palmetto which may be found growing in the vicinity of the date or cocoanut trees to be protected. The sap which exudes from the dead or wounded trees ferments and acts as a strong attraction to the beetles. Frequently a multitude are thus attracted and can be captured without trouble and killed before they have had time to oviposit. The trunks of felled trees soon become filled with larvæ, and infested portions should be sawed off and burned before the insects mature, leaving the remainder of these trunks to act as traps for other insects. It is also recommended that care be taken in the choice of sites for new plantations, undue proximity to what is known as a "cohoon" ridge being avoided, and that all stumps and felled trees not used as traps be promptly destroyed. Thorough drainage and wide planting are also advised. The trees should be left as far as possible in a natural state and unnecessary trimming should be avoided. Wounds might be dressed with any mixture that would deter the beetle from attacking them and prevent fermentation, such as tar or grafting wax.

The beetles can easily be killed by dropping them into hot water.

Some of the remedies above described were first suggested by Mr. Blandford (*loc. cit.*) and others by this Division.

Mr. Seay is most successful in the treatment of the palm weevil by the use of traps, which have been in use for many years by himself

and others, both against this species and related ones. "The traps he uses are mostly what is termed the cabbage portion of the palm, while it is fermenting. When fresh cut, the "cabbage" will attract the weevils somewhat, but when it reaches the vinous stage it emits a powerful odor, which the insects can detect from a great distance. They soar about for a while, then alight and proceed to work. After feeding for some time, they look about in search of a "nice heap of rubbish to hide and sleep in, but if no suitable place is close, they fly away. The idea of a handful or two of rubbish catching them took me five years to find out," says Mr. Seay. "I kept trying everything I could think of to hold them, but as soon as the vinegar fermentation sets in, the weevils stop coming and the yellow bugs [ambrosia beetles] come; also several kinds of flies." When the putrid stage arrives, Mr. Seay destroys his traps. The "salt-water pimento" is the palm most used, and one or two cuts of a machete an inch or an inch and a half above the "cabbage" takes off the top, and with the point of the machete a hole is opened into the "cabbage," breaking it a little. Then the trap is set. The odor arising from these bruises attracts the insects in the vicinity, and the weevils enter the holes and also stow themselves in the leaf-stalks. In the afternoon of the following day until 2 or 3 o'clock our correspondent states that he frequently obtains half a dozen or more in such a trap. The trap lasts a week or two. When the trap has been thus used, it is cut off below the "cabbage," and the scraps are burned or thrown into the sea.

There seems little doubt that all of the flying species of insects—the weevil, the Histerid, and the two-winged flies—whose larvæ were received are instrumental in spreading the disease or so-called fever which attacks palms grown both in British Honduras and in the West Indies. Mr. Seay is unfortunate in having neighbors who also grow palms and who do not take the pains to employ remedies against the weevils. He states that 3 or 4 miles is no distance for the insects to fly in search of a sickly tree or one that is beginning to bear fruit, because then the bark is soft and the sun will make cracks and the sap, which is liked by all of these pests, oozes out in quantities.

NOTES ON THE RHINOCEROS BEETLE.

(*Dynastes titys* Linn.)

By F. H. CHITTENDEN.

Few insects attract greater attention when they occur in any numbers than the giant Scarabæid known as the rhinoceros beetle, *Dynastes titys* Linn., sometimes called the spotted hornbug. In former years it was tolerably abundant in the vicinity of the District of Columbia, and is still to be found quite frequently in neighboring portions of

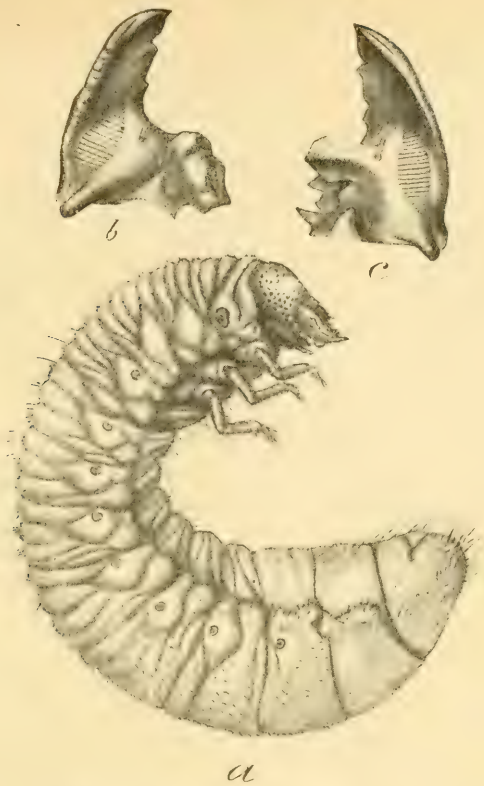


FIG. 1.—*a*, Larva (natural size); *b*, *c*, mandibles of larva (enlarged)

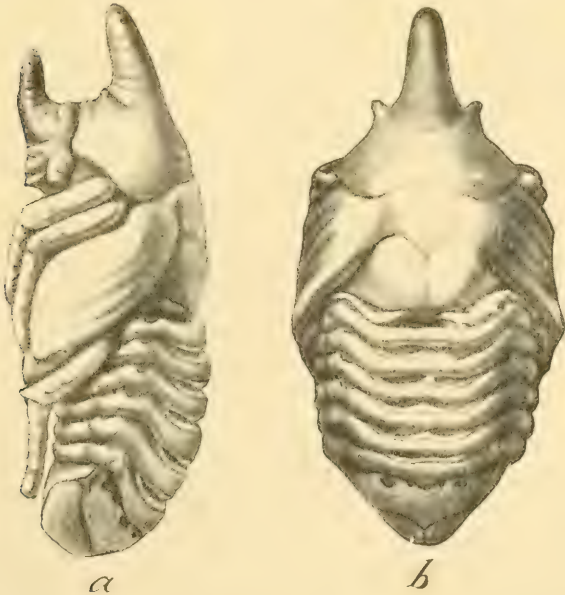


FIG. 2.—Pupa: *a*, lateral view; *b*, dorsal view—natural size

RHINOCEROS BEETLE (DYNASTES TITYUS).

Virginia, and more commonly southward. It was not until the year 1891 that any considerable information regarding the insect's earlier stages was published. In that year Dr. J. A. Lintner published in his Seventh Report on the Injurious and Other Insects of the State of New York an extensive account (pp. 246-255), which included detailed descriptions of the larva and pupa by Mr. E. A. Schwarz, of this Division, with figures prepared in this office under the direction of the late Dr. Riley. These illustrations, not hitherto used in departmental publications, are now used as an accompaniment to the present notes, which add somewhat to our knowledge of the life history of this our largest and most striking native beetle.

Recently Dr. A. K. Fisher, of the Biological Survey of this Department, furnished the writer with a pair of this species from Sandy Spring, Md., and from these July 16 we obtained the egg and later the young larva. As this stage has not hitherto been described, the following description is submitted with other notes:

DESCRIPTION OF THE EGG AND YOUNG LARVA.

The egg of *Dynastes tityus* looks precisely like a very small bird's egg.^a In outline it is broadly oval and perfectly symmetrical, of firm consistency, and quite elastic. It is of a dull cream color and without polish or visible sculpture. The length of a freshly deposited egg is a little more than $\frac{1}{8}$ inch (3.5^{mm}), and the shorter diameter 3^{mm}.

The newly hatched larva is nearly a counterpart of that of *Lachnosterna* and related white grubs, being about double the size and width of that of *Lachnosterna arcuata*, which was figured and described by the writer on pages 74 and 76, respectively, of Bulletin 19 (n. s.), of this office. These differences, however, are observable: The head is larger, more globular, darker brown in color, and of firmer consistency, being more strongly chitinized than that of *Lachnosterna*; the mandibles are proportionately shorter and less sickle-like, and the teeth are nearly the same on both sides, the single tooth being placed nearer the tip of the mandibles. [In *Lachnosterna fusca* there are two teeth on the left side, near the base of the mandibles, and only one tooth on the right side.] The legs are proportionately shorter and the pubescence longer.

DESCRIPTIONS OF LATER STAGES.

For the benefit of those who have not seen this species, the accompanying illustration of the male is furnished, slightly enlarged, in figure 2. It measures from $2\frac{1}{4}$ to $2\frac{1}{2}$ inches from the tip of the horns to the end of the body. The female is similar, but is unarmed with horns. The general color above is a pale bluish gray in life, and the

^a It should be noted here that the egg of a large African Buprestid, *Sternocera orissa*, has been found by Dr. Howard to measure 9.2x6.4^{mm} (Ent. News, Vol. VII, p. 244).

elytra, or wing-covers, are marked with darker irregular spots similar to those on many kinds of birds' eggs. The ventral surface is a bright mahogany brown, and moderately hairy.

The larva, shown in Plate II, figure 1, at *a*, in natural position, is of the usual curved Scarabæid form, dirty yellow or yellowish white in color, measuring when mature upward of 5 inches in length when extended. Enlarged illustrations of the mandibles are shown at *b* and *c* of the same figure.

The pupa is light brown in color and covered with a very fine velvety pruinosity. The male is illustrated in Plate II, figure 2, *a* showing a lateral view and *b* the dorsal, natural size.

The peculiar odor of the beetle is shared by larvæ and pupæ and lasts long after death, preserved specimens seeming never to lose this strange scent, which also remains for years in the insect boxes in which the beetles have once been kept.

In the reports of Dr. Lintner rather full bibliographical references can be found.

DISTRIBUTION.

The exact distribution of this species has never been defined, hence the following list of localities from which specimens have been sent by correspondents of this Department together with some recorded localities should be of interest, this beetle being so well known to collectors of insects:

York County, Marietta, Lancaster, Wrightsville, Pa.; Cape May, Wildwood, N. J. (Smith); Baltimore, Hughesville, Sandy Spring, Centerville, Md.; Washington, D. C.; Amherst, Sewells Point, Bonney, Perrowville, Gills, Friedens, Coffee, Culpeper, Warren County, Va.; Wilkesboro, Raleigh, Happy Home, Fayetteville, Hooverhill, Greensboro, Asheville, Laurelbranch, N. C.; Coozan, Coronaca, Beaufort, Winnsboro, Pomaria, S. C.; Molino, Liveoak, New Smyrna, Archer, Fla.; Smithville, Pearson, Albany, Ga.; Florence, South Calera, Birmingham, Mobile, Selma, Ala.; New Orleans, Cypress, Gansville, La.; Covington, Memphis, Claiborne County, Tenn.; Ojo Caliente, Grafton, N. Mex.; Louisville, Scottsville, Ky.; Hackett City, Ark.; Paoli, Columbus, Ind.; Missouri.

BIOLOGIC NOTES.

The date of deposition of the egg was not ascertained, but was about July 18, or a few days before. When examined a week later it was

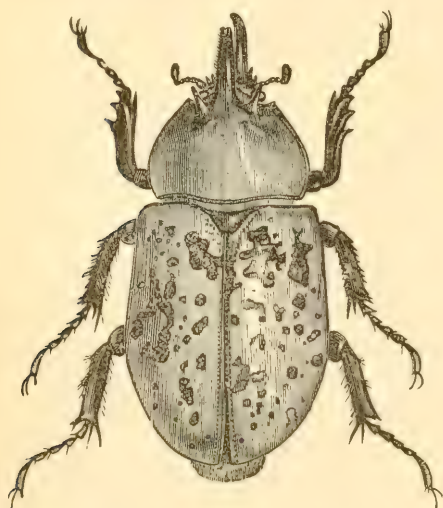


FIG. 2.—Rhinoceros beetle (*Dinastes tityus*): male—slightly enlarged (after Riley).

found to have grown half a millimeter in diameter by a process of absorption well known in eggs of the beetles of this family.

The exact duration of the egg stage could not be observed, but it was at least sixteen days and probably longer, the weather for this period being a little warmer than normal.

Several years ago the writer received from the late George D. Bradford, at that time traveling in the South, a number of larvæ of this species collected in the spring at Beaufort, S. C., from which material some interesting observations were made.

For several weeks after the receipt of these larvæ they did not manifest any signs of feeding, but later in July and August they ate freely of the mold or dead woody matter in which they were sent. There was originally over a gallon jar full of this mold, and as that in the jar was consumed, the remainder, perhaps a quart, was added. Three larvæ were kept in this, and almost the entire contents had become consumed and converted into pellets, resembling on a small scale those of a goat or rabbit, when the larvæ became full fed. They ceased feeding during the third week of August and remained for a few days as if resting, then went to work to form cells for the pupal transformation. When larvæ are disturbed they roll over and over, like the larvæ of many other Coleoptera and some other orders of insects, and the same motion was continued by the pupa. By this motion, in time, the interior of the pupal cell is rolled quite smooth.

August 27 the skin was noticed to be shriveled, and on the following day this increased. On the 29th all three pupated. One was still white toward evening, the other brown. Transformation to the imago occurred on the 20th of October, all undergoing this metamorphosis the same day. This gives a pupal period of fifty-one days, probably the longest warm weather pupal period of any of our Coleoptera.

The pupal cells were coated externally with excremental pellets and bits of rotten wood, and showed an average measurement of from 2 to 3 inches in length and $1\frac{1}{8}$ to $1\frac{1}{4}$ inches in width.

Hibernation takes place normally in the beetle state, and the beetles obtained in this instance were kept until some time in July of the following year, when they died during the writer's absence.

The rhinoceros beetle seldom occurs in such abundance as to be reckoned a pest. According to Dr. Lintner, however, the beetles are sometimes capable of injuries of considerable importance. He states (Fifth New York Report, p. 230), on the authority of Mr. J. W. Murrell, Perrowville, Va., that numbers of the beetles were observed feeding on the tender shoots of spring growth of ash trees, causing the leaves to fall and cover the ground as if a frost had passed over them. Their food consists largely of sap, which flows from the plants attacked. Beetles may be attracted by bruising ash twigs.

The beetles are sometimes troublesome on account of their strong and disagreeable odor.

Ash, although evidently the favorite, is not the only food plant of this species. The larvae are probably not particular, as they live upon decaying wood and have been found feeding in decayed wood of cherry, willow, oak, and other trees.

During June, 1898, we received a specimen of this species from Mr. W. W. Thompson, Smithville, Ga., with the statement that it had been found eating a pear, an unusual food habit, judging from records.

In writing of the noise produced by this species when alarmed, the late Dr. John Hamilton says (Can. Ent., Vol. XVIII, p. 112):

While no real stridulating organs are present, they have the power to produce a sound that may answer the same purpose, somewhat resembling that of an angry goose. The pygidium and part of the last ventral segment are very hairy, and by withdrawing the abdomen from the elytra so as to admit air, and then suddenly forcing it out through the hair by a sudden extension, a noise is produced that is rather alarming to one unacquainted with their harmlessness.

NOTES ON ENEMIES OF MUSHROOMS AND ON EXPERIMENTS WITH REMEDIES.

By AUGUST BUSCK.

During the winter 1901-2 four enemies of mushroom culture came under observation: (1) snails, (2) roaches, (3) maggots of some undetermined Diptera (not bred), and (4) mites.

(1) Against the snails was used with perfect success the old remedy of trapping them under loose boards.

(2) The roaches (*Periplaneta americana*) were quite troublesome, but were at least temporarily driven away by the pyrethrum and bisulphid of carbon experiments, employed against the mites and mentioned below.

(3) The maggots, which in the cases under observation were scarce and of small importance, were not bred. They worked in the fruit bodies of the mushroom and of course spoiled such individual mushrooms as were infested. Possibly the experiments with all kinds of insecticides, conducted against the mites, killed the majority of adult flies, and thus prevented egg laying and consequent injury.

Reports from other places show that certain flies (*Phora* spp. and *Drosophila* spp.) may be very dangerous enemies of successful mushroom culture.

The present experiments tend to show that the screening of all windows or beds, where feasible, and the liberal use of pyrethrum, are effective preventives against these pests.

(4) The only truly important and at the same time the most pernicious and difficult enemy to handle which has come under my observation hitherto is the very prolific and astonishingly destructive mite, *Tyroglyphus lintneri*.

It attacks the fruit bodies in all stages, thereby making these unsightly and unsalable. When present in large numbers it actually eats big holes right through them. It not only attacks the fruit bodies, but even feeds on the mycelium underground, thus destroying the plant entirely.

Many cases where beds have not yielded at all, and where the blame has been credited to "old and dead" spawn, are doubtless truly the results of this pest, which being so small has escaped notice.

In two or three cases where the failure of a bed was attributed to poor spawn, it was found on investigation that the "brick" had been all right and had begun sending out mycelium under favorable conditions, but that myriads of these mites in the ground actually consumed it as fast as it grew. In some beds they were so numerous that they covered the surface entirely, and any such bed might as well be given up at once, and the danger to surrounding beds somewhat minimized by the killing of all the mites. This may be done by pouring boiling water on the bed, using enough to reach the bottom and soak the bed thoroughly.

The following remedies were thoroughly experimented with and none proved of much value:

(A) *Bisulphid of carbon*.—Some twenty-odd beds, 3 by 6 feet, and two beds, 5 by 10 feet, were under observation in two different places. These beds were originally prepared with these experiments in view, and the boxes were made $1\frac{1}{2}$ to 2 inches higher than is usually necessary, so as to leave that much space above the ground. In other respects the beds were prepared in the usual manner, the spawn was put in, and in due time mycelium developed and mushrooms appeared.

As soon as the mites put in their appearance (they were probably brought in the adolescent stage with the manure) the bisulphid of carbon was applied. From one-fourth of a pound to 1 pound was poured into each of three or four shallow receptacles placed on top of the bed, and the whole was then tightly covered with heavy oilcloth.

This was done in the evening and the bed left overnight till the next noon, when the soil was examined.

It is possible that some of the mites had perished from the effect of the poison. Several were found dead or dying, but many more specimens crawled upon and in the soil as lively as ever and apparently not the least harmed.

The treatment was repeated next night on some of the beds, and for several nights on other beds, but with the same very doubtful success.

A number of living mites were placed in a vial on a bit of mushroom and the vial closed with cotton saturated with bisulphid of carbon. After two days several mites were still alive, and the cause of the death of the others may as well have been lack of moisture or injury in handling them as the bisulphid of carbon.

One thing was ascertained through these experiments, namely, that the mushroom mycelium is not injured by the treatment with vapors of bisulphid of carbon; in fact, the growth seemed rather stimulated if affected at all, and such beds, when not ultimately killed by the mites, produced as good a crop as those not treated. The fruit bodies above ground, however, can not stand the treatment, but disintegrate very soon, for which reason all should be plucked before the application.

(B) *Pulverized sulphur* was applied liberally with a blower, and mixed with about 1 inch of the top soil by means of a rake. Aside from such mites as were injured in the handling, and such as were actually buried in the sulphur, from which they had difficulty in extricating themselves, none seemed in the least affected.

(C) *Vapors of sulphur*.—The burning of chips of sulphur in proper receptacles on top of the beds did not have any apparent effect on the mites.

(D) *Pyrethrum powder* applied liberally with bellows had no serious effect on the mites, though they evidently did not like it. It did not seem to act even as a deterrent in such beds as were little or not at all infested. However, the undoubted beneficial results against roaches and flies, which might otherwise have become serious factors, would warrant the use of this insecticide freely in all mushroom beds as a good precaution.

(E) *Hydrocyanic-acid gas*.—Conditions did not allow a thorough test of this, but I have no doubt, from what was done, that it is as ineffective against the mites as bisulphid of carbon. One large bed in a cellar by itself was left from Saturday 4 o'clock to Sunday 4 o'clock, exposed to the fumes of hydrocyanic acid, produced in the usual way. When the windows were pulled open on Sunday strong fumes were still found.

No living mites were noticed at the inspection on top of the bed, but digging into the bed the following day revealed them apparently as well as ever. Concerning the influence of these vapors on the growing mycelium this experiment gave no information, as the mycelium in this bed was already dead when exposed to the gas.

(F) *Tobacco dust* was tried in a single bed, and gave the same negative result as sulphur, acting at most only as somewhat deterring but not killing the mites.

(G) *Chloride of lime and gasoline*.—Neither was given sufficient trial to warrant final conclusions. The former killed the mites which came in contact with it, but two beds on which it was applied did not produce any mushrooms either. The gasoline did not seem to have any fatal results either to mites or mushrooms.

(H) *Moisture*.—A mushroom bed does not allow much variation in moisture if good results are to come. However, it was soon observed

that the mites easily got too much moisture, and in this direction observations should be continued to find out whether it be possible to find a degree of moisture which will either kill or drive away the mites without being detrimental to the growth of the mycelium.

NOTES ON COLORADO INSECTS.

By A. N. CAUDELL.

Acting under authorization from the Department of Agriculture, I arrived at Denver, Colo., May 5, 1901, where I was joined by Dr. H. G. Dyar. With Denver as headquarters, daily excursions were made into the canyons and foothills of the mountains, and the life histories of many western Lepidoptera were worked out, notes being taken on more than 200 species. In the months of July and August trips were made across the divide to various localities, adding materially to our collections. According to instructions, I "collected such economic and other insects as came convenient and made observations on economic species whenever possible." My first duty of assisting Dr. Dyar in working out lepidopterous life histories prohibited my making large collections in other orders. Some 5,000 specimens of Orthoptera, however, were collected, together with some hundreds of miscellaneous insects, mostly Coleoptera, of which a few were reared. Such observations on economic insects as I was able to make are here reported.

The minute false chinch bug (Nysius minutus Uhl.).—At Delta occurred an extreme case of injury to radish by this insect. The leaves were completely killed to the ground, and the shriveled remains were still covered by many hundreds of the little pests. Mr. O. Heidemann identified the species.

The beet army worm (Laphygma erigua Hbn.).—This has become an important enemy of the sugar-beet industry in the West. Specimens of the larva in all stages were taken on sugar beets at Palisades in Mesa County, and at Delta. At the latter place they were taken also on the table beet, though they did not occur in injurious numbers. This insect is reported as having caused great injury to sugar beets in Colorado, defoliating thousands of acres of beets. It is also said to be injurious to potato, pea, and apple leaves. Professor Gillette, of the Colorado experiment station, has employed arsenical sprays against it with beneficial results. Professor Forbes concludes from data furnished by Professor Gillette that there may be expected at least two broods of larvæ each year—one in June and one in August. But the broods doubtless merge one into the other, as larvæ in all stages were taken at Palisades on July 8.

The bean ladybird (Epilachna corrupta Muls.).—An extreme case

of injury by this spotted bean beetle was observed near Fort Collins, where a large patch of beans had nearly every leaf killed by the larvæ of this insect. At that time, in July, the beetles were in the pupal state, hanging in great numbers on the underside of the leaves. Professor Gillette stated that no effective remedy for them was known, the insect being able to withstand anything that did not injure the plants. The adult beetles are said to exude a tiny drop of yellow liquid of a pungent odor from each knee joint when disturbed. The insect is discussed by Professor Gillette in Bulletin 19 of the Colorado Experiment Station.

The apple flea-beetle (Haltica bimarginata Ill.).—July 19 a collecting trip was made up Platte Canyon. At Pine Grove, some miles up the canyon, the alders along the river were found to be infested by beetle larvæ which ate the upper side of the leaves, in some cases completely skeletonizing them. An attempt was made to rear the adult beetle, but other duties interfered and it was not successful. A number of the larvæ were collected, however, and Mr. Schwarz identifies them as those of *Haltica bimarginata*.

The tent caterpillar (Clisiocampa fragilis Stretch).—On July 20 the ascent of Pike's Peak was made, and here occurred the worst case of forest depredation by insect foes that ever came under my observation. The aspens were completely defoliated by the larvæ of *Clisiocampa fragilis*. The imagos were then issuing, and, even in the middle of the day, they swarmed about the tops of the leafless trees like bees, thousands and thousands of them. The cocoons literally covered the twigs, one a foot in length often containing a dozen or more of them. So completely defoliated were the trees at this place that Dr. Dyar failed to find a single leaf with which to supply an aspen-feeding Notodont larva which he was rearing. Our observations were made mostly at 9,000 to 12,000 feet altitude. The willow and rose were also attacked, but not nearly so severely as the aspen. Over what area this injury extended I can not say, having been unable to make sufficient observations. In the vicinity of Cripple Creek the aspens were also infested, but not nearly so badly as those on Pike's Peak. On reaching the summit of the peak we found hundreds of the moths lying dead or helpless on the snow banks. They had evidently flown up from the timber line, and, becoming benumbed, fallen in the snow, there to die.

The lilac borer (Podosesia syringæ Harr.).—In West Denver numbers of ash trees were completely killed by this Sesiid borer. The trees were small, about 6 inches in diameter, and dozens of empty pupal shells were protruding through the bark.

The fruit-tree leaf-roller (Cacacia argyrospila Walk.).—The leaves of living ash trees were badly infested with the larvæ of this Tortricid.

A new tent caterpillar (Clisiocampa tigris Dyar).—The scrub oak in the eastern foothills, especially just west of Sedalia, between Denver and Colorado Springs, was badly infested with the larvæ of this new

species of *Clisiocampa*. Many of the trees (or more properly bushes, as they seldom, if ever, attain sufficient size to be properly called trees) were killed through repeated defoliation by the larvæ of this insect. A resident farmer stated that the caterpillars were much more numerous some years than others. This beautifully marked larva was first found some 5 miles up Platte Canyon, back of Denver, but occurred there very sparingly. It eats only oak and confines its attacks to young, tender leaves. It seems unable to eat old leaves, and so must mature before they become tough.

The eggs are laid near the ground on twigs at the base of the trees, and have no frothy covering as have many species of the genus. The larvæ are gregarious when young, but soon scatter and feed singly. They spin no web.

Trypeta galls on Bigelovia.—At the little station of Platte Canyon, at the mouth of the canyon of that name, there are great numbers of *Bigelovia*. During the latter part of May every bush bears a number of white fluffy but compact galls as big as hazelnuts. Often there will be found 50 or more galls on a single bush. They are caused by a beautiful little fly, *Aciura bigeloviae* Ckll. At this time of the year the pupæ may be found within the galls, snugly incased in cells at the center. The pupa is about 5^{mm} long by 3^{mm} wide, oval in shape, and varying in color from pale yellowish red to brown, probably according to age. The insects emerge by the first of June, the first ones appearing in the breeding cage on May 28.

The cabbage looper (Plusia brassicæ Riley).—In the early part of July a few observations were made on injurious insects of the garden in the vicinity of Delta, in Delta County. Several interesting items were noted. The larva of *Plusia brassicæ* was the main pest, and seemed to be quite omnivorous, eating not only the cabbage, but also the potato, turnip, rutabaga, lettuce, and table and sugar beets; it was also found on a prickly poppy-like plant locally called "wild lettuce." While the cabbage in some cases was almost ruined, it was on the lettuce and potato, especially the lettuce, that the most damage was done. Quite large fields of potatoes were so eaten by this larva as to be easily noticeable at a considerable distance, having something the appearance of being badly infested with the potato beetles. On the lettuce the damage was extreme. In some cases the plant was entirely devoured and was eaten out below the surface of the ground. The rutabagas and peas were also badly eaten. The larvæ occurred in various stages, some very small and others full grown. Specimens were sent to Dr. Dyar at Denver to be reared, but they failed to transform. An inflated larva was preserved.

The cottonwood leaf-beetle (Lina scripta Fab.).—The willows in the eastern foothills visited by Dr. Dyar and myself were badly infested with a Chrysomelid larva which often occurred in sufficient numbers to completely skeletonize the leaves of large branches. The beetles were

reared, and were determined by Mr. Schwarz. The eggs are deposited on the leaves about the middle of May, and are continually deposited for two or three weeks thereafter, all stages—ovum, larva, pupa, and imago being found on the trees in the earlier part of June. They remain in the pupa state about five days, specimens in the breeding cage pupating on June 1, and giving forth imagos on the 6th. The larval period lasts but a couple of weeks, and breeding experiments would probably show the insect to be at least double-brooded.

The bollworm, or corn ear-worm (Heliothis armiger Hbn.).—Young corn a couple of feet in height near Delta was badly infested with the bollworm. The leaves were in some cases completely riddled near the base, and the stalks badly burrowed and eaten. This exceptional injury was probably accounted for by the nearness of the worst infested patch (a small area) to an irrigating ditch of considerable size. Corn in dryer locations seemed little injured. Corn on low wet soil is usually much more liable to excessive injury from the corn worm than on high dry ground. Some years ago in Oklahoma I saw a small area of field corn planted in a very low wet spot in the bend of a small creek that was completely eaten up by the worms. The stalks attained a height of only about 4 feet and were very weak and slender, yet 20 or more larvæ could be found in a single plant, burrowing the stalks so that many fell over. Some plants had all the leaves riddled and the stalk so completely eaten out that but part of the outer shell remained. So numerous were the larvæ that many of them were in a fully exposed position, feeding upon the leaves.

Grasshoppers. Grasshoppers were very abundant in Colorado this year. Several reasons may be assigned for their unusual numbers. The season was favorable for their development, and the increasing abundance all over the State of the Russian thistle, which is a food plant of a large number of species, may have had considerable influence in the matter. Professor Bruner suggested also that the rapid killing off of pheasants may be a cause of grasshopper increase.

The prairie along the eastern foothills was swarming with various kinds of Acridiinae. *Melanoplus bivittatus* was probably the most common species. At Delta this locust threatened to do some damage, and it occurred sparingly at Grand Junction, while at Palisades, 12 miles north, none at all were seen. This is a very injurious species, and Professor Gillette places it on an equal footing with the codling moth as an injurious insect.

The saltbushes, *Sarcobates vermicularis*, about Palisades were infested with *Æoloplus chenopodii* Brun. in large numbers. A small patch in the center of the little town was swarming with them. They were quite active, diving headlong into the prickly bunches of weeds, and proved quite difficult to capture. They were not at all common at Grand Junction, and were not taken on the saltbush there.

GRASSHOPPER NOTES FOR 1901.

By LAWRENCE BRUNER, *Temporary Field Agent.*

Owing to numerous reports received at Washington from many localities in the central West concerning the continued presence in more than normal numbers of several species of native grasshoppers or locusts, the subject was deemed worthy of investigation. Reports coming from portions of western Nebraska, eastern Colorado, and eastern and central Wyoming seemed so serious in their nature that the writer was commissioned by the United States Department of Agriculture to make an investigation, so as to ascertain, if possible, the true causes leading up to this undue increase among the several species of locusts concerned, and to report the results to the Entomologist.

Accordingly, August 8, in company with Mr. M. A. Carriker, jr., an assistant, who was to make some special observations and collections of specimens for the Nebraska Agricultural Experiment Station, a start on this tour of inspection was made. The route chosen was first to southwestern Nebraska via the Denver branch of the Burlington and Missouri River Railroad, and the first stop was at McCook. From this place the party proceeded by short journeys to Haigler, then to Akron, and to Brush. At the latter place turning to the north, and passing through Sterling, Colo., Sidney, Nebr., Bridgeport, and Scotts Bluff, they reached westward as far as Guernsey, Wyo., before returning to Alliance, Nebr., and Lincoln, by way of the Billings branch of the same railroad. On this return journey the central sand hill region was crossed and some notes on locust abundance were there secured.

Leaving Lincoln again on August 18, a second journey was made; this time via the Fremont, Elkhorn and Missouri Valley Railroad up the Elkhorn Valley, the Niobrara, the White River, and the North Platte, to Lusk, Douglas, and Casper, Wyo., where investigations were made concerning the locust problem as it existed in those regions; then returning as far as Crawford, in which vicinity some work was done, and finally going on to Denver, Colo., where the annual meeting of the economic entomologists was attended. From here the return trip to Lincoln was made over the Union Pacific Railway down the Platte River Valley. Thus most of the remaining territory occupied by the locust pest under consideration was covered. In these investigations the writer was greatly aided by having transportation furnished him by the railroad companies mentioned.

Other sections of the country were also visited and carefully studied, both before and since the period embraced by the commission mentioned, and the results of such investigations have been included in the conclusions arrived at and hereto appended.

The following notes pertaining to the subject under investigation were jotted down as the work progressed, and in part form the basis for the conclusions reached:

At McCook, Nebr., August 9, we collected some thirty-odd species of the native grasshoppers, which abound in this vicinity. Most of these were from common to numerous as regards abundance. In fields, both on the table-lands and in the valley, the *Melanoplus differentialis* was exceedingly abundant; in fact it appeared to be the principal species that was causing the injury to crops and cultivated plants. It was aided, however, in this work by such other forms as *M. bivittatus*, *M. atlanis*, *M. packardii*—of the form usually referred to as *M. fiedus*—and *M. femur-rubrum*. Among the other species which existed in unusually large numbers were *Dissosteira longipennis*, *Æoloplus turnbullii*, *M. occidentalis*, *M. conspersus*, *M. lakinus*, *Amphitornus bicolor*, *Aulocara eliotti*, *Mestobregma kiowa*, etc.; but these latter were feeding mainly upon grasses, weeds, and special food plants other than cultivated ones.

In trying to ascertain just where the insects which were concerned in the devastation of crops had hatched, it was found that old breakings seemed to furnish many, while the forsaken roads, edges of fields and irrigating ditches, railroad beds, and like places, grown up to weeds, had provided still others with the required breeding places. Alfalfa fields growing next to corn nearly invariably occasioned much injury to the corn. Some of the fields of corn observed between McCook and Culbertson had been entirely destroyed, and in some instances even the weeds between the rows and about the edges were badly eaten. A few fields showed only here and there the remnants of bare stubs, just as I had seen fields appear in the early seventies after a visit from the Rocky Mountain locust plague.

In observing what plants, if any, were free from the ravages of the various locusts mentioned above, it was noticed that sorghum in most cases had suffered but little, while Kaffir corn was nearly exempt. Only when Kaffir corn was wilted did the locusts seem to touch it at all, and then but slightly if other food was available. Millet, too, seemed to be fairly immune against their attacks. Of course most kinds of garden truck suffered severely.

One feature noted in connection with the abundance of the supposedly harmless locusts was the presence in large numbers of *M. lakinus* and *Æoloplus turnbullii* on the Russian thistle and lamb's-quarters. Nearly everywhere that these weeds grew the grasshoppers just mentioned abounded. Only a few years ago both of these species of locusts were rare, usually extremely rare, and at the same time very local in their distribution. Since they have already been observed to attack the beet, they may both prove troublesome in the future should attempts be made at sugar-beet growing in the regions now overrun.

On the prairies and other uncultivated grounds two or three grasshoppers besides those mentioned above seemed to be abnormally abundant, *Mermiria bivittata*, *Opeia obscura*, and *Amphitornus bicolor* or

coloradensis being the chief ones. These, with the exception of the first, are found upon the higher grounds among the shorter grasses like the *Boutelouas*.

In driving and walking about over the country, in which movements 10 or 12 miles at a time were covered, few dead or sick locusts were seen, and inquiry among the farmers and other interested parties gave the same impression as to their comparative healthiness. No *Empusa*-killed 'hoppers had been seen by anyone during the present year, so far as could be learned, and only a few had been observed to die from "grubs" and from what is apparently either a bacterial disease or such a disease in conjunction with a *Sporotrichum*. At least this last surmise seems to be warranted, since the conditions of death coincide with observations made a week prior in an alfalfa field on the North Platte, about 17 miles to the northwest of the little town of Ogallala, where the locusts of various species had succumbed in large numbers. When these were placed in a dish for the purpose of ascertaining the cause of their demise there was obtained a fungous growth, pronounced by Dr. C. E. Bessey, of the University of Nebraska, to be a species of *Sporotrichum*. Several bacteria were also present in large numbers within the bodies of some of the above-mentioned dead locusts.

Inquiries made among the railroad employees at McCook showed that these insects reached eastward as far as Red Cloud in numbers sufficiently great to perceptibly injure cultivated vegetation in both gardens and fields.

In passing westward from McCook along the line of the Burlington and Missouri River Railroad, locust injury was observed all the way to Haigler, but seemed to be the most pronounced between the former place and Stratton.

From different persons questioned concerning the various measures that had been taken to combat the locusts in this portion of the State, it was learned that the kerosene pan had been used in a few cases, while disking had been resorted to by some, and several had even attempted the use of poison in the form of Paris green mixed with bran. In some instances also large flocks of chickens and turkeys produced some good results. Altogether, however, but little had been accomplished, and no concerted action had been undertaken by the settlers to rid themselves of the pest. It would require a concerted action over the entire area affected, for at least two or three years in succession, to obtain complete control of the pest.

Whether or not the killing off of the native birds in this section of the State has been much of a factor in permitting this abundance of the locust is a query. One farmer near McCook remarked that a couple of years ago a certain locality near one end of a particular field of his had been protected by blackbirds, a hundred or more pairs

of which built nests and reared their young near by. Recently, however, the small willows among which these birds nested had been removed, and the birds no longer protected that particular field.

At Haigler it was ascertained that various species of locusts have been more than normally abundant for the past six years. At least this can be said of the species which attack cultivated plants like alfalfa, corn, wheat, garden truck, etc. If any change in their numbers has occurred it is thought that perhaps there is a slight decrease from last year. As in the vicinity of McCook and farther east, they seem to breed chiefly in alfalfa fields, along roadsides, and in old breakings. In addition to the breeding places here recorded, the Russian thistles, which have become generally dispersed over this section of the State, seem also to offer safe and desirable retreats for several species of these insects when laying their eggs. Not only is this true at egg-laying, but also at other times. These rank-growing plants provide shelter during hot, dry weather, as well as from rain and hail storms, and offer safe retreats to the insects, even when pursued by such enemies as predaceous insects and birds.

Of the enemies to wild plants among these insects those which appear to be most beyond the normal in numbers in this vicinity seem to be *Opeia obscura*, *Mestobregma kionra*, *Melanoplus lakinus*, *M. boarditchi*, *M. packardi*, *Mermiria birittata*, *M. neomericanus*, and one or two others. As noted at McCook, several of these latter are partial to certain food plants which have recently increased enormously, which fact probably explains their excessive numbers. On the other hand, species like the *Mermirias* and other grass-infesting forms now abnormally abundant have become so from some other cause. Perhaps the nonoccurrence of prairie fires for a number of years may account for this, at least in part, while the destruction of such birds as the sharp-tailed grouse and Bartramian sandpiper, with the meadow lark, and a few other kinds of prairie-inhabiting species, will explain the excess in numbers of some of the remaining grasshoppers. Three species of *Decticinae* were also quite abundant here, as was also one of the walking sticks.

In journeying westward from Haigler grasshopper injuries were detected nearly as far as Akron, Colo., but beyond this point only about the normal numbers of these insects appeared to be present, since none of their injury was visible from the train. At Brush, where a great deal of alfalfa is grown, not many of these insects were reported or seen. Hence it was judged that matters here were nearly normal as regards locust abundance. From this point the direction of the journey was changed and we went north. At Sterling, which was passed before daylight and where considerable injury was reported a year ago, the condition was not ascertained, but judging from what was seen some distance beyond along the line of railroad toward Sid-

ney the locusts may be on the decrease—a result, perhaps, of some concerted efforts on the part of the farmers toward their destruction during the past two or three years.

It was also found upon investigation that these insects were not nearly so numerous at Sidney as they were farther to the east along the Lodgepole Creek and the South Platte River. Still, even at Sidney, wherever and whenever cultivated fields occurred, more of these insects were to be met with than is normally the case in the region. They were of the usual species observed under similar conditions the present year, viz., various species of the *Melanopli*, as *differentialis*, *bivittatus*, *femor-rubrum*, and *atlantis*. Some of the other forms that were not so rare as at times in the past were species like *M. packardii*, *M. occidentalis*, *M. luridus*, *M. infantilis*, etc., while a few of the prairie-inhabiting species mentioned before were also quite plentiful.

In conversing with Mr. George Oberfelder, a merchant of Sidney and a ranchman, I learned that at Lodgepole the locusts were not nearly so plentiful on his ranch as elsewhere in the neighborhood. It developed from further conversation with him that on this particular ranch are located several quite extensive private fish ponds and low and swampy ground, where two or three species of blackbirds breed, and were, at the time referred to, gathered in immense flocks. The presence of these birds will undoubtedly explain this comparative freedom from locusts on the ranch in question. Mr. Oberfelder also mentioned the fact that a great destruction of the bird life, in general, of the region had been accomplished during recent years by local and other would-be sportsmen.

While at this place, in conversation with a gentleman from Gering, Scotts Bluff County, it was learned that during the present year there were more grasshoppers in the Pumpkinseed Valley, to the south of Gering and Mitchell, than there were last year, and also more during the present year (1901) than at Gering and Mitchell. This he accounted for on the ground of a partial migration southward both by the old insects prior to their egg laying last fall, and again since hatching during the past spring and early summer. Just what species of these insects were present in this last-named region was not ascertained, but it is presumed that most of them were of the kinds noted at nearly all other points where cultivated vegetation suffered from grasshopper depredations. It is also quite evident that several of the prairie-frequenting species like *M. packardii*, *M. occidentalis*, the *Aulocaras*, some of the species of *Trimerotropis*, *Trachyrhachis kiowa*, *Opeia obscura*, etc., were present in more than normal numbers, since a scarcity of food on the ranges is reported, notwithstanding the fact that more than the usual amount of rain had fallen during the past spring and summer.

In running west from Bridgeport to Guernsey, Wyo., it was observed

that locust depredations appeared to lessen materially as the train progressed westward after entering Wyoming. Still even here more of these insects were to be seen among the weeds along the railroad track than was the case during their normal abundance in past years. There were a number of kinds to be met with in the grasses about Guernsey, but the prevailing species seemed to be *M. packardii*, *M. occidentalis*, *M. atlantis*, *Anlocara elliotti*, *A. femoratus*, and still others, which, like *M. differentialis* and *M. atlantis*, seem to hatch among rank-growing weeds as well as upon cultivated or disturbed grounds.

In trying to find a reason for the greater increase of locusts in certain localities during different years, the matter of rainfall seems to offer an explanation for at least a portion of this variation. It is quite noticeable that when rains fall early in the season the eggs of these insects hatch much earlier than they do when the rains come later, although the temperature may be normal or even above normal. Then, too, after each shower during late spring and throughout the summer, it is seen that additional young ones hatch. During some years it may even be possible for many of the eggs that were deposited the previous fall to remain unhatched for lack of the requisite amount of moisture. Should the following year prove to be a wet one these eggs might then hatch along with those deposited a year later. That the present year has been an exceptionally wet one in portions of the Northwest may, therefore, account for the immense numbers of grasshoppers that were to be found in that section. Still, there are limited localities even in this region where scarcely any of these insects were to be met with during the present summer, while immediately adjoining they were literally swarming. While returning eastward from Guernsey a severe rainstorm accompanied by hail was passed through. Fully an inch and a half or two inches of rather large hailstones fell over a strip of country several miles in width and many miles in length. During the progress of this storm the thought occurred to me that possibly here was an explanation of the comparative freedom of certain areas right in the midst of others that were greatly overrun by destructive locusts. The hail in this instance certainly fell with force and in quantity sufficient to crush out the life of the majority of locusts inhabiting the region in question. Then, too, these sections of comparative freedom from the pest so frequently observed by the writer are such as are subject to severe hailstorms.

As intimated on a previous page, the Russian thistle, in addition to affording an abundant food supply for certain species of the native locusts, provides excellent shelter for their eggs as well as the insects themselves. Tucked away beneath these formidable plants both the insects and their eggs are well protected from most of their natural enemies, as well as from sudden changes of weather. This being true, the Russian thistle no doubt must have had something to do with pro-

ducing the present conditions in portions of the region now covered by the locust plague.

At Caspar, Wyo., August 20, conditions while rather bad were not nearly so alarming as they were in some portions of Nebraska, and farther east in Wyoming. In driving out among the ranches and over the range some new light on the probable cause of the recent increase among grasshoppers in this and other regions of the country was secured.

Upon driving up to the buildings on a ranch on Goose Creek, about 10 or 12 miles southeast from Caspar, a very nice flock of sage grouse (30 or more) was observed walking about the premises and picking up grasshoppers. These grouse were so tame that they reminded one of domestic fowls as they worked about among the vegetation in search of grasshoppers. During the day several additional coveys of these grouse were seen and the remnants of several dead birds that had been shot and drawn by hunters offered opportunities for examining the stomach contents. Such examinations invariably resulted in the finding of large quantities of grasshopper fragments. By inquiring around among ranchmen it was also ascertained that a great slaughter of these birds had been going on for the past few years in the sections of Wyoming now most overrun by locusts. A careful survey of the field brought out the fact that a similar destruction of these birds, as well as of the sharp-tailed grouse, has been progressing over considerable country. It was learned that such slaughter had occurred at Chadron, Crawford, Harrison, McCook, Culbertson, Trenton, Haigler, North Platte, and Sidney, in Nebraska; and at Lusk, Douglas, Orin Junction, Guernsey, and elsewhere in Wyoming. At each of these localities the grasshoppers were more numerous during the past summer than formerly.

When this idea first came up in connection with other probable reasons for the increase of the various species of locusts found it did not seem at all probable, but the more I consider it, the more I am inclined to accept it as an important factor in the problem. When we take into consideration the fact that when man occupies a new area he finds the forces of nature nearly or quite in a state of equilibrium, no one form of life having much the advantage over others, then does this explanation of the matter appear quite possible. The country undisturbed by man affords food for a certain number of mammals, birds, reptiles, and insects, all of which are more or less interdependent. If, for instance, man removes a few hundreds of the individuals of any one species, he soon finds a change taking place in the numbers of individuals of some other form. The birds feed on both vegetation and insects. If grasshoppers are included in their food a smaller number of birds will require a less number of 'hoppers, and the latter will thus be given the opportunity to increase beyond the normal. This

surplus goes on increasing and very soon causes a greater drain on the vegetation that forms their bill of fare. Supposing that a single sage hen will destroy on an average 100 locusts each day during the months of June, July, and August, the removal of this bird from the field of action will mean at least 9,000 grasshoppers saved to swell the army of these insects that may go on eating and propagating. If half of these should be females, and each one should deposit its normal quota of 100 eggs, there would be a possible 150,000 more of these insects than if the bird had not been killed. But when we destroy the birds by the hundreds of thousands the possibilities become startling, and this solution to the problem seems more than probable.

Aside from the killing off of these birds by man, it is stated that they are destroyed to a considerable extent by grazing sheep which break up their nests. While conversing with an intelligent sheepman and herder on this feature of the subject, he mentioned the fact that he had heard of more than a hundred nests being thus destroyed in a single year on Hams Fork in western Wyoming. Whether or not the destruction of locusts by the trampling of sheep will equal the number that would have been killed by the birds thus destroyed, I am not prepared to state at this time.

The species of grasshoppers concerned in the depredations on cultivated tracts in the vicinity of Douglas and Casper, Wyo., were: *M. bivittatus*, *M. atlantis*, *M. femur-rubrum*, and *Camnula pellucida*; while the ones most abundant on the range were *Aulocara elliotti*, *A. femorata*, *Mestobregma pardalinum*, *Melanoplus packardii*, *M. infantilis*, *M. occidentalis*, and several others.

While occupied in other work in portions of Dawes and Sioux counties during June, July, and August, 1901, the writer gave considerable attention to the locust problem as it existed there. A couple of students who were engaged in making collections of various forms of the animal life of northwestern Nebraska were also instructed to pay particular attention to these insects in the region being worked by them. The forms that frequent both cultivated and uncultivated grounds were found to be unusually abundant over much of the country traversed. Still some sections were much more overrun by them than others. Especially was this found to be the case in portions of Dawes and Sioux counties, Nebr. In the latter county in particular the insects were most plentiful on the slopes adjoining the Pine Ridge and for a few miles away; but not so on the table-lands nor in the Hat Creek Valley itself. In many places the insects were so numerous as to cause a shortage in the feed on the range notwithstanding the great amount of rain that fell here during the early part of the year. As noted in other localities, some species of insects normally rare in this section of the State were found to be present in large numbers.

Not only were the "native" locusts abundant throughout the western

counties of Nebraska, but in many localities even in the central and eastern portions of the State, where they did much local injury to garden truck and some field crops. Some of the localities where such a state of affairs existed were in Antelope, Knox, Dixon, Cedar, Holt, Valley, Custer, Lancaster, and counties adjoining these. In these sections the differential, two-lined, red-legged, and lesser migratory species predominated, though others were also present in fair numbers both upon the prairies and in cultivated fields. A number of the local districts thus overrun were visited by myself or some member of the entomological department of the University of Nebraska, while others could not be reached for investigation. It was found that some of these outbreaks embraced only a few farms or several hundred acres of territory, while others extended throughout entire counties. The species of locusts concerned in these also varied with the districts and the nature of surroundings and crops grown. It was noted, however, that *Melanoplus differentialis* and *M. bivittatus* were usually the chief offenders.

One of the most important of these local or detached areas of locust abundance was that in Custer County, with Broken Bow as a center. In this region the plague assumed really alarming proportions, and caused not a little uneasiness among the citizens, who earnestly sought aid from the State entomologist and all other persons who might be in a position to give expert advice.

After carefully going over all the notes which have been brought together during the various trips made while investigating this and other insect pests and those accumulated in other ways, it is found that the area now occupied by these insects in injurious numbers has become much larger during the present summer (1901) than it was a year ago. Practically all of the State west of the one hundredth meridian is embraced, while the valleys of the Niobrara, Elkhorn, North and South Loup, Platte, and Republican rivers are all more or less largely overrun for 50 to 100 or more miles eastward. In some instances this is true locally, even to the extreme eastern edge of the State.

In order to show clearly the principal species of locusts thus concerned, and their distribution over the country, the following list has been prepared:

Mermiria bivittata Serv.—McCook, Haigler, Sioux County, and in the sand hills generally on unburnt prairies.

Mermiria neomexicana Thom.—Haigler and other southwestern Nebraska localities, where it is found in company with the preceding species.

Amphitornus bicolor Thom.—A plains locust which occurs from middle Nebraska westward to the Rocky Mountains, where it is to be met with in great numbers, especially on the higher grounds among the shorter grasses.

Opeia obscura Thom.—McCook, Culbertson, Haigler, Sidney, Scotts Bluff, Crawford, and Harrison, Nebr.; Akron, Sterling, and Brush, Colo.; and Guernsey, Douglas, and Casper, Wyo.; most abundant in buffalo grass.

Alpha occipitalis Thom.—Western Nebraska and eastern portions of Colorado and Wyoming; partial to gravelly and sandy soils.

Alpha crenulata Bruner.—Southwestern Nebraska, western Kansas, and the plains of Colorado, in company with the preceding.

Phliobostroma quadrimaculatum Thom.—In the same general region as the two preceding.

Ageneiolettix scudderi Bruner.—This locust occurs throughout the plains region, but is most abundant among the short grasses on high grounds.

Boöpedon nubilum Say.—Observed in abnormal numbers at Haigler and Stratton, Nebr., and Wray, Colo.

Aulocara elliotti Thom.—McCook, Culbertson, Haigler, Sidney, Scotts Bluff, Sioux County, Nebr., and Guernsey, Lusk, Douglas, and Casper, Wyo. It was also present in abnormal numbers in portions of western Kansas and eastern Colorado. It is a grass-infesting insect.

Aulocara femoratum Scudd.—With the preceding species, but most abundant southward.

Camnula pellucida Scudd.—This locust was seen only in the extreme western part of Nebraska and at Casper, Wyo., where it occurred on low land about streams and in mountain meadows.

Dissosteira longipennis Thom.—A native of the high prairies of western Kansas and Nebraska and eastern Colorado and Wyoming; not nearly so abundant as it was four or five years ago.

Mestobregma kiora Thom.—A grass-infesting locust that occurs everywhere between the Missouri River and Rocky Mountains, but chiefly on high ground.

Mestobregma pardalinum Sauss.—A grass insect found chiefly in western Nebraska, northeastern Colorado, and eastern and central Wyoming.

Schistocerca alutacea Harr.—This insect was reported to be present in large numbers at Neligh, Albion, Haigler, Ogallala, and throughout the sand hills of central Nebraska generally.

Hesperotettix pratensis Scudd.—Antelope, Holt, and Wheeler counties on the prairies, but usually on low ground, where certain species of golden-rod abound.

Hesperotettix viridis Thom.—Eastern Colorado and Wyoming and western Nebraska, where it is restricted to certain localities.

Hesperotettix speciosus Scudd.—Western Kansas and Nebraska and eastern Colorado, among different species of sunflowers.

Eoloplus turnbullii Thom.—In the same general region as the preceding, where it seems to be partial to chenopodiaceous plants.

Eoloplus regalis Dodge.—Northwest Kansas, southwest Nebraska, and eastern Colorado, on rather high grounds.

Melanoplus bowditchi Scudd.—Western Kansas and Nebraska and eastern Colorado and Wyoming on *Artemisia longifolia*.

Melanoplus flavidus Scudd.—This insect was noticed in numbers at Culbertson, Sidney, Scotts Bluff, North Platte, Ogallala, and Neligh, Nebr., and at Guernsey, Wyo. It appears to be partial to low, sandy soil.

Melanoplus packardii Scudd.—McCook, Culbertson, Haigler, Ogallala, Sidney, North Platte, Crawford, and Harrison, Nebr., Wray and Sterling, Colo., and Guernsey, Douglas, and Caspar, Wyo. The rufous form usually mentioned as *M. foedus* is by far the most numerous.

Melanoplus coccineipes Scudd.—Fairly abundant at Culbertson, Sidney, Ogallala, North Platte, and Fort Robinson, in Nebraska, where they seemed to choose *Cleome serrulata* as a food plant, or at least upon which to perch.

Melanoplus infantilis Scudd.—On the high prairies in western Nebraska and eastern Wyoming.

Melanoplus femur-rubrum De G.—Throughout the region in cultivated districts.

Melanoplus plumbeus Dodge.—At Haigler, Nebr., on weeds and other rank vegetation.

Melanoplus lakinus Scudd.—Western Kansas and Nebraska and eastern Colorado, on Russian thistle and lamb's-quarters.

Melanoplus occidentalis Thom.—On the open prairie, west of the one hundredth meridian, in all four States in which work was done during the summer.

Melanoplus atlantis Riley.—Cultivated grounds generally, but less numerous than *M. femur-rubrum*.

Melanoplus bivittatus Say.—In nearly every locality where locust depredations were reported, and especially in cultivated districts.

Melanoplus differentialis Uhler.—Possibly the most abundant of all the species of locusts mentioned in this paper, and present in all localities except those in the extreme northwestern corner of Nebraska and central Wyoming. The chief insect in alfalfa districts.

Of these the following species seem to be confined more or less closely to special food plants, and are therefore somewhat restricted in their distribution:

Hesperotettix pratensis Scudd.—On *Solidago graminifolia* or *S. caroliniana*.

Hesperotettix viridis Thom.—On *Haplopappus spinulosus*.

Hesperotettix speciosus Scudd.—On *Helianthus*, several species.

Eolophus turnbullii Thom.—On Russian thistle and lamb's-quarters.

Melanoplus bowditchi Scudd.—On *Artemisia longifolia*.

Melanoplus lakinus Scudd.—On Russian thistle and lamb's-quarters.

Those which are especially noticeable as enemies of cultivated crops are *Melanoplus differentialis*, *M. bivittatus*, *M. femur-rubrum* and *M. atlantis*, along with *M. packardii*. The remainder are chiefly grass eaters or feed upon various uncultivated plants.

WHY LOCUSTS INCREASE ABNORMALLY.

After having carefully scrutinized the notes relating to the locust problem in the region embraced in the investigations chronicled on the preceding pages, together with all other available information on the subject in general, the writer has come to the following conclusions as to why grasshoppers increase abnormally:

- (1) The growing of alfalfa without regularly disking the ground each spring.
- (2) The abandoning of once cultivated fields, and permitting thereon the growth of weeds and other rank herbage.
- (3) The very general carelessness of allowing weeds and other rank growths to flourish along roadsides, irrigating ditches, and railway tracks.
- (4) The presence in great abundance of the Russian thistle in portions of the country year after year.
- (5) The non-burning of prairies over wide areas for a number of years in succession.
- (6) The undue destruction of game and other insectivorous birds over wide areas.
- (7) The recurrence of unusually wet years after several abnormally dry ones.
- (8) The absence of insect enemies and diseases brought about by various causes, chiefly climatic.

It is but just to state here that lack of space prevents a very elaborate discussion of these various reasons for locust increase.

KILLING DESTRUCTIVE LOCUSTS WITH FUNGOUS DISEASES.

By LAWRENCE BRUNER, *Temporary Field Agent.*

The fact that various kinds of insects are at times attacked and destroyed by different species belonging to several distinct genera of fungi has been known to both botanists and entomologists for many years. It is, however, a matter of comparatively recent discovery that some of these fungi can be artificially grown and afterwards communicated to the insects which it is desired to destroy. Numerous examples of the propagation and spread of such fungi have been recorded in this and other countries. Some noted examples of this kind are the artificial spread of *Isaria densa* Link, the fungus that attacks the European cockchafer and that has also been tried on the white grubs here in the United States; *Sporotrichum globuliferum* Spag. as used against the chinch bug and several other insects, and *Empusa muscæ*, the common fungus of the house fly. Along with what has been recorded concerning these attempts at utilizing the fungi just mentioned, it might be well here to outline some of the efforts that have been made during recent years toward fighting destructive locusts or grasshoppers by similar means. It is not necessary, however, for one to devote much time in investigation to ascertain that the whole matter relating to this subject is still in great confusion. It will at once be apparent that nothing very definite exists in the shape of reliable information concerning the particular fungi that may be present and available in each of the regions where there is need for waging war against the locust plague. Even the botanists who are interested in this group of plants seem to have done comparatively little toward isolating and separating the species, from the standpoint of the systematist.

During the early seventies, when such vast swarms of the Rocky Mountain or migratory locust were devastating the country between the Mississippi River and the Rocky Mountains, attention was frequently called to an apparent disease which occasionally made its appearance among the devouring hordes of that pest in various sections of the country. After a little investigation on the part of members of the Entomological Commission and others, this fatality among the locusts was found to be due to the presence of a fungus which is now generally recognized as *Empusa grylli*, although it has been several times described under other names.

While locusts in general are more or less frequently attacked by these fungi, particular ones among the locusts indigenous to each country seem to be more subject than others. These usually, though not always, happen to be the forms that at times become so greatly multiplied as to be pests. This fact would indicate that it is necessary for the insects to come in contact one with another in order to spread the fungus sufficiently to develop an epidemic.

These epidemics of the disease usually occur during warm, wet weather, or after such conditions of climate have been prevailing for several weeks in succession. They are also quite apt to develop among the insects living along the edges of irrigating ditches or on grounds which have been thoroughly watered, rather than on those which are comparatively high, dry, and more or less widely removed from water or rank, succulent vegetation.

Early in 1896 (March) the subject of utilizing locust-attacking fungi as a means of destroying these insects came more prominently before the public. In South Africa, where two species of these insects had been a pest for several years, it was found that a disease of a virulent nature had broken out and was prevalent in the form of an epidemic among the swarms in certain localities. An investigation instituted at the time showed this disease to be due to the presence of one of these species of fungi. Armed with the assurance that other insects had been successfully inoculated and destroyed by fungous diseases in Europe and the United States, members of the staff of the Bacteriological Institute in that country took the matter in hand and were successful in their attempts to isolate a fungus which was thought to be the one that was destroying the insects in question, a species of large migratory locust (*Aceridium purpuriferum* Walk.). A brief account of the methods followed and results obtained from this work is given by Alexander Edington, the director, in his annual report for 1898 of the Colonial Bacteriological Institute, located at Grahamstown, Cape of Good Hope.

A year or so later (June, 1897), during investigations that were being made at the time in connection with the large migratory locust of the Argentine Republic (*Schistocerca gregaria* Burm.), the writer discovered what appeared to be still another and quite distinct species of these locust-destroying fungi—a *Sporotrichum*. This discovery was made at Carcaraña, a little town in southern Santa Fe, on the Central Argentine Railway, and some experiments conducted later during the same year demonstrated its usefulness, under certain limitations, as a means of combating that insect. The South African fungus referred to above was also tried on the same locust, but with exceedingly poor results so far as could be ascertained at the time. Still more recent attempts at destroying various kinds of our North American locusts with both of these fungous diseases (South African and Argentinian) have resulted in no marked degree of success, so far as the writer is concerned at least.

During the past two or three years other persons have been conducting similar experiments with these same, and apparently some other, locust-killing fungi. A few of these recent experiments carried on by other workers seem to have proven more successful than those just mentioned above. One in particular appeared to be very prom-

ising at the time it occurred. This was at Sterling, Colo., and was conducted by a Mr. George W. Martin, who obtained tubes of the fungus culture from the Department of Agriculture in Washington. The writer on visiting the locality found that, although the native locusts of two or three species were dying in large numbers, they all fell to the ground instead of clinging to the vegetation, as they should have done if death had resulted from the South African disease according to the account referred to above. Then, too, reports of similar fatalities among the 'hoppers, coming from localities widely removed from where the fungus in question had been distributed, seemed to indicate the presence of another and entirely distinct disease. During the present year (August, 1901,) a culture of a species of *Sporotrichum* has been secured from such dead insects gathered on the North Platte River and about 16 miles from Ogallala, Nebr.

In Australia it is reported that a fungus determined as *Mucor racemosus*, cultures of which were obtained from South Africa, has proved so useful in destroying the destructive locusts of Victoria that it is no longer considered an experiment, but has passed into a matter of everyday practice. Either this same *Mucor* or a closely allied one is also claimed to have been secured from insects which died as the result of an outbreak of a locust disease in Mississippi, as will be referred to more fully further on.

It will be seen from what has just been said that there are without doubt several distinct kinds of these locust-killing fungi, and that they are not the same the world over. The knowledge of this fact is perhaps very fortunate if we are to profit at all in our attempts to make use of them in dealing with the locust pest.

Since each species of locust differs in structure and habits more or less markedly from all others, and the climatic and other conditions by which they are surrounded in their respective habitats are so dissimilar in many instances, it must be true that a great diversity likewise exists among them as regards hardiness. Hence it is natural for us to suppose that the various fungi which are apt to attack and destroy them must also vary in these respects. That such a conclusion is warranted can be gathered from what follows.

EMPUSA GRYLLI.

Perhaps the most characteristic of these different locust-attacking fungi is the one recognized the world over as *Empusa grylli* Fres. It has been known, botanically at least, since 1856, when it was first described by G. Fresenius (*Botanische Zeitung*, Band XIV, p. 882, 1856). Not only does it attack the different species of destructive locusts (members of the family *Aceridiidae*), some of the hairy caterpillars, and a few of the crane flies along with their larvæ, but it is also frequently to be found as an enemy of various other orthopter-

ous insects. Among these latter it has been observed especially as an enemy of some of the representatives of the two remaining families of saltatorial Orthoptera—Locustidæ and Gryllidæ.

This malady is quite readily recognized, since the host when affected by it has a tendency before death to crawl upward upon the vegetation where it chances to be at the time of infection. Here it grasps the leaf, twig, or stem closely and fastens itself so securely that it remains clinging tenaciously even after death. As stated above, all kinds of locusts and also their relatives are affected alike by it; and many of their dead bodies may frequently be seen still attached to the vegetation in late fall and early winter. Just what the pathological effect is upon the victim, which causes this tenacious grasping or clutching with the front and middle legs, may never be known. Yet, in a general sense, it may be remarked that all insects dying from the effects of any of the allied species belonging to the genus *Empusa* exhibit this same characteristic of climbing before death. Even such characteristically subterranean insects as the various species of *Ceuthophilus*, or camel crickets, when attacked by this fungus, are known to leave their customary moist, dark haunts and climb up bushes and other vegetation even to the height of several feet, where their dead bodies may occasionally be seen hanging for some time afterwards.

Whether or not the *Empusæ* which attack the various orthopterous insects in different portions of the earth are identical in species is not definitely known, although they are supposed to be so by some of the leading mycologists who have studied these peculiar parasitic plants. Be this as it may, minor variations in growth and structure have been noted among the forms indigenous to the different countries where collected and studied. These differences have led to the multiplying of names, so that we now have at least three distinct names, if not that many actual species.

An insect, when once attacked by this fungus, soon shows signs of unrest and ceases feeding. It shortly becomes "dumpish" and in due time attaches itself to the vegetation as stated above. The whole body, but more especially the abdomen, swells greatly and seems to be literally filled with a mushy, granular substance which, upon drying, changes to a brownish, dust-like character. A little later this dust, which is made up largely of resting spores, escapes through the breaks between the joints of the insect's body and is scattered broadcast by the winds.

Comparatively little is known concerning the life cycle of this fungus or of the methods by which infection of the host occurs from year to year. That it must be done by contact rather than through the alimentary canal is quite probable, judging from reports of experiments made by Dr. Roland Thaxter and mentioned in his Monograph of the Entomophthoræ of the United States. The resting spores must also

be exceedingly tenacious of life, since several years may elapse between outbreaks of the disease. Still no such regular intervals of recurrence of the disease have been noted as would tend to show a periodicity. Neither does there seem to be a regular time of the year for its appearance, nor has it a preference for insects of any particular age, since those of all ages seem at one time or another to succumb to its attacks. Sometimes, though rarely, it may be noticed first in late spring or early summer; at others, and more frequently, during midsummer, and again even in late summer and early autumn, or possibly not until just before cold weather commences in late fall, when it seems to be most common.

Dr. Thaxter says: "The artificial propagation of *Empusa* by the infection of fresh hosts I have found a much more difficult matter than one would suppose, even where the infected host was of the same species as that from which the spores were obtained for this purpose." (L. c., p. 152.) Not alone has Dr. Thaxter found this difficulty in securing artificial infection, but other persons have also learned the same fact fully when attempting to make use of the fungus as a means of destroying locusts. In truth, the writer has found it impossible to impart the fungus artificially to a single insect in either the laboratory or the field. It might be well, however, to state here that these experiments by the writer were purposely carried on in a very crude manner, since their object was to secure results that might also be obtained by farmers who are not equipped with carefully arranged laboratories.

If we make an exception of the matter on this subject that has been reported from the Bacteriological Institute of Grahamstown, Cape of Good Hope, it appears that up to the present time all of the experiments that have been attempted for the purpose of growing this fungus artificially in the laboratory have been very unsatisfactory. After having studied the subject carefully by reference to the available literature, and noting critically such facts as appear pertinent, and which are given below, it is the writer's opinion that the exception just suggested is justifiable.

The typical region for *Empusa grylli* is Europe, and in that country perhaps it has been most frequently reported. But the reader should not infer from this statement that this fungus is of rare occurrence elsewhere, for such is not the case. Here in North America it is among the most abundant of fungus plants, and it is to be regularly met with each year in suitable localities throughout the length and breadth of the land. In fact, it very frequently occurs as an epidemic among the locusts in regions where various species of these insects have developed as pests. This same or a closely allied fungus was occasionally referred to by correspondents as indigenous to Argentina while the writer was in that country several years ago, and quite recently notices of its occurrence in Japan and the Philippine Islands have been seen.

By referring to the annual report of the Director of the Colonial Bacteriological Institute of the Cape of Good Hope for 1898 it will be learned that the much-advertised South African locust fungus has been determined by the working force of that institution to be an *Empusa*; and the name *Empusa acridii* has been suggested for it since it was reported to have attacked other species than the red locust (*Acridium purpuriferum* Walk.), one of the chief destructive species of that section. Plates I, II, and III, which are photographic reproductions accompanying that report, show these locusts as they appear upon the vegetation after death caused by the fungus. Judging from what is known concerning the actions of insects after having been attacked by different fungi, a person who is conversant with the subject would at once pronounce the malady portrayed here to be that resulting from the presence of an *Empusa*. To verify this conclusion in part we have the following records: Mr. Charles P. Lounsbury, government entomologist, in the Agricultural Journal of the Cape of Good Hope, February 2, 1899, says that the disease is apparently identical with *Empusa grylli*, and quotes as authority for this statement Dr. Schönland and Dr. Black, of the Bacteriological Institute of Natal. Also Dr. Munro, in his book on the Locust Plague (p. 182), quotes from a Mr. Evans as follows:

On the 4th of this month I wrote a letter stating that a fungus had been found in a locust causing its death, and it was afterwards determined by Mr. George Murray, F. L. S., head of the botanical department of the British Museum, as *Empusa grylli*.

While the insects in question have apparently died as a result of the presence of an *Empusa*, an entirely different fungus appears to have been isolated from the dead locusts and afterwards grown in quantity and sent out from the laboratory to be utilized in fighting the same pests. In this report, referred to above, we find a description and illustrations of a fungus which in no wise resembles or approaches *Empusa*. In fact, both the descriptions and figures suggest a *Mucor* instead, and possibly the world-wide distributed *Mucor racemosus* Fres., which does not belong to the insect-destroying fungi at all, but to the ordinary molds. Strangely enough the tubes of the so-called South African locust fungus received by the writer, both while in Argentina during 1898 and here in Nebraska two years later, contained fine growths of what was evidently the above-named *Mucor*.

In glancing over the files of the Journal of the Department of Agriculture of Western Australia for July, 1901, a statement was found to the effect that "The destruction of locusts by means of a parasitic fungus (*Mucor racemosus*) has now passed from the domain of experimentation into that of everyday practice. The method which has been tried in various places where swarms of locusts proved troublesome to vegetation, notably South Africa, has been for the past two or three years successfully applied in Victoria."

The Agricultural Gazette of New South Wales (vol. 10, 1899, p. 1213) contains "A brief report of locust fungus," by D. McAlpine, in which the writer says that a fungus which has been used against locusts at Cape of Good Hope with good success has also been introduced into New South Wales and identified by him as *Mucor racemosus*.

In looking up the bibliography of the fungus called *Mucor racemosus* it was found that two quite distinct plants have received this name. One of these was described by Bulliard in Hist. Champs., France, and is said by DeCandolle to belong to the genus *Botrytis* as now limited. The name of this fungus would then appear as *Botrytis racemosa* (Bull.) DC.; while the other, which has been the one under consideration, should be known as *Mucor racemosus* Fres. (Beiträge zur Mykologie). The *Botrytis* has been found upon putrid, oily, or greasy substances in France and Germany, while, on the other hand, the *Mucor* occurs quite generally over the world as a common mold that attacks decaying, starchy, and other substances.

Being so generally distributed, and withal so readily grown, there is no wonder that this last mentioned should have been the fungus isolated, as heretofore stated, instead of the *Empusa*, which is extremely difficult to grow upon various culture media, such as are used for the artificial propagation of bacteria.

It might be mentioned also that in our experiments here at the University of Nebraska we have experienced great difficulty in isolating any particular fungus, and especially with recognized insect-attacking genera like *Empusa*, *Botrytis*, *Sporotrichum*, and *Isaria*. Almost invariably these would be accompanied by saprophytic fungi, such as *Mucor*, *Fusarium*, *Alternaria*, *Macrosporium*, *Aspergillus*, etc., which would very quickly crowd the others out.

If the reader will take the trouble to refer to the instructions which accompany the various tubes of this South African locust fungus when they are distributed he will find the following directions given for securing an abundant supply of the material:

Collect a large number of grasshoppers which have died from the fungus. Dig a hole in the ground about 18 inches deep and 1 foot wide. Strew some grasshoppers over the bottom, then sprinkle some water over them. Repeat with grasshoppers and again sprinkle until the hole is full. Do not press the grasshoppers in the hole, but leave them lightly packed. Then cover with a piece of tin or board and keep the hole thus carefully covered for four or five days. If warm weather, four days will be sufficient, but if colder a longer time will be required. At the end of this time remove the grasshoppers and spread them out in the sun for an hour or two, or until thoroughly dry. Now grind them into a meal. Of this meal, which may be kept dry for a long time until wanted, take two tablespoonfuls and add it to a large tumblerful of water, into which some sugar has been placed. Leave this in a warm place for twelve to forty-eight hours, and then treat live grasshoppers by dipping, etc., just as one does when using the fungus when supplied in tubes.

If such a proceeding as that just described does not result in the growth of a variety of common molds, *Mucor racemosus* among them,

nothing will do so. Even had the insects which were collected and buried been killed by poison, boiling water, heat, or in some other violent manner, and treated in a similar way, the result would in all probability have been quite similar. But when these insects die from disease and drop to the ground in a variety of localities, and later are gathered together, there is no telling how many different kinds of saprophytic fungi may have come in contact with and adhered to them. Even *Empusa*-killed insects, attached to vegetation a considerable distance from the ground, would themselves become infested, and under favorable conditions support a great variety of these molds.

In our experiments with the fungus mentioned in this paper as *Mucor racemosus* we have found that such locusts as have been dipped or sprinkled with sugar-water cultures of it are killed; but when turned loose in the field there is no apparent spreading of the fungus to other 'hoppers. Neither did we have any success in destroying them when the inoculation was attempted by feeding the fungus to the insects along with bread crumbs, etc., that had been used for culture media. It is surmised that by thus dipping the insects into the liquid containing the fungus some of the mycelial threads and spores of the latter enter the stomata, as well as the sutures between the rings of the abdomen and thorax, and start to grow, and in a short time use up the fluids and vital tissues of the body sufficiently to cause death.

Since none of the other fungous diseases of locusts, aside from that caused by *Empusa grylli*, seem to have received much attention heretofore, it has been thought best to devote some space to their discussion here. Especially does this seem warranted because of the numerous references made to them in these pages.

SPOROTRICHUM sp.

The first of these other locust-attacking fungi that deserves mention was discovered by the writer in 1897 while investigating the destructive locust problem of Argentina, South America. In the month of June, when the insect then under investigation was hibernating, or, more correctly speaking, resting, and confined chiefly to the more northern districts of that country, it was thought best to occupy the time in gathering data of various sorts. It was on one of the field excursions which were regularly made at intervals, as this work was progressing, that dead fungus-covered nymphs of the destructive locust were discovered securely tucked away in dense bunches of a species of grass common to a large portion of the open country. These dead *saltonas* (as the nymphs of these insects are called in that country) had evidently been destroyed by the fungus in large numbers during the previous year. Still, so securely were they tucked away in these clumps of grass that fully eight months later they not only remained nearly perfect in form, but also retained their colors sufficiently to make their identity certain.

Having had some previous experience with an insect-destroying fungus of a similar appearance in the destruction of quite a different insect in the United States, a preliminary examination of these fungus-covered locusts at once suggested a *Sporotrichum*. But in order to obtain a verification of this surmise, or to learn definitely the nature of the find, specimens of the dead fungus-covered insects were submitted to Prof. C. E. Bessey, of the University of Nebraska, who reported that the identification was correct. Although the genus to which this South American locust-killing fungus belongs has been definitely settled, various unavoidable circumstances have thus far prevented its specific identification.

Locusts that have been attacked by this South American fungus, instead of climbing to the top of various plants so as to get as much air and light as possible, creep away from the light and seek dark, moist places in which to die. Consequently they are most often found hidden away near the roots of bunch grasses, in the midst of dense, juicy foliage. Here, after death, their bodies become entirely filled with mycelial threads and spores of the fungus. In many cases, under certain conditions, the fungus growth also appears upon the outside and almost completely covers the dead body of the insect.

Some breeding-cage experiments attempted later in the year indicated that the fungus could be quite readily transmitted from these dead fungus-covered saltomas to live, healthy locusts of the same species. While out in the open "camp," the invading swarms soon began dying in rather large numbers in the vicinity where the fungus had first been discovered. On gathering the dead bodies of these latter and pulverizing them, and afterwards strewing this powder upon others along with their food, the result was that they too were found to sicken and die.

The action of this fungus upon the host is similar to that of *Sporotrichum globuliferum* on the chinch bug. At first the victim becomes restless, ceases feeding, and begins to wander aimlessly about, and, shortly before death, it seeks a secluded spot in some dark nook upon or near the ground. Quite frequently, after a passing flight of an infected swarm, the ground was found to be strewn with the dead bodies of such insects as had succumbed to the disease. These soon turned bright pink in color, and where they failed to reach a sufficiently moist and shady place shortly became quite hard and leathery in texture instead of rotting and breaking into fragments, as is customary with dead insects of this class. Also at the "roosting places" of such swarms many of these pinkish-colored locusts were found upon the ground, having succumbed and dropped during the night. Some of these latter, although winged, have been known later to exhibit the characteristics of those shown in the illustration already referred to.

During the period in which this fungus was epidemic among the

locusts in the southern portion of Santa Fe, and while under the observation of the writer, only four distinct species of locusts were found that had died as the result of its attack. These were the large migratory species of Argentina and the neighboring countries, *Schistocerca paranensis* Burm., *Zoniopoda tarsata* Serv., *Diponthus communis* Brun., and *Dichroplus elongatus* Giglio-Tos. It might be of interest, however, to know that each of these, aside from the *paranensis*, becomes locally destructive at times. This fungus, like *Empusa*, flourishes best during warm, humid weather.

Having obtained such satisfactory results in transmitting this disease to other locusts while conducting experiments in Argentina, a quantity of dead fungus-covered insects, like those described above, were gathered and brought back to the United States for use in attempting to destroy our North American species. Accordingly, in July and August, 1898, large numbers of several of our most common *Melanopli* were gathered and placed in breeding cages along with a goodly supply of green food and the bodies of the dead fungus-covered insects. The powdered bodies of such dead locusts were also strewn over the food and moistened earth at the bottom of the cages. In addition to these, similar experiments were attempted in fields where our native locusts were exceedingly numerous, but in all cases these experiments failed to show a single instance of the possible transmission of the fungus to our native species.

More recent attempts at obtaining an artificial growth of this South American locust-killing fungus on various media in the laboratory have likewise proved utter failures, the reason for this being, no doubt, the great age of the material at hand.

Notwithstanding the failures in the experiments just recorded, this, in the opinion of the writer, is one of the most promising locust-attacking fungi, since it was found to withstand considerable variation in climate and to attack at least four widely different insects. Then, too, its close relationship with the so-called chinch-bug fungus (*Sporotrichum globuliferum*) gives us some reason for encouragement in the future.

On July 17, 1900, a letter was received from Mr. George W. Martin, Sterling, Colo., who had undertaken some experiments with the South African locust fungus, a supply of which was furnished him from Washington. This letter reads as follows:

DEAR SIR: I have succeeded in killing a large number of grasshoppers on 60 acres of alfalfa, covering the ground with them for one-fourth mile. The disease is still spreading and is now 500 yards from where the infected ones were placed. I do not see why it will not kill all of them. I use corn meal, 2 parts sugar, 1 part, for dose, feeding at 4 p. m., again 6 p. m., putting them out at 7. I drive over the fields to be infected. The fungus seems to be better a week old than earlier.

Yours, truly,

GEORGE W. MARTIN.

A visit to the locality, as already stated, revealed the fact that although several species of native locusts were dying in large numbers, yet, contrary to the rule with insects that had been attacked by *Empusa*, these Colorado 'hoppers all fell to the ground instead of remaining fastened to the vegetation. About the same time, and also somewhat later in the season, other reports were received of similar epidemics occurring among the grasshoppers in localities where no infection of any kind had been distributed. This year again other reports of similar epidemics occurring among these insects were received here at the University of Nebraska. One of these was so remarkable in nature that a representative of the experiment station visited the locality to make an investigation. He was also requested to secure specimens of the dead and dying insects so as to ascertain, if possible, the cause of the epidemic. Other material was received at the station from correspondents, and from both of these lots of dead insects there was obtained, among other things (as *Spirillum* and *Bacterium*), a *Sporotrichum*, the specific identification of which was not ascertained at the time, as the botanists were then all away on their summer vacations. Since their return school duties have prevented their giving the necessary time to the matter, hence we can only suggest that this may be a second species of the genus which attacks locusts.

While most of these local outbreaks among our native locusts occur in moist localities, such as irrigated fields and bottom lands, the one near Ogallala, Nebr., was in a field which irrigation did not reach, and came at a time when little or no rain had fallen for several weeks. The species of locusts found generally among the dead were *Melanoplus differentialis*, *M. bivittatus*, *M. atlantis*, *M. femur-rubrum*, *M. packardii*, *Spharagemon collaris*, *Brachystola magna*, and *Dissosteira carolina*; these were numerous in the order named; a very encouraging record when we take into consideration the differences in the habits and structure of these insects. All the occurrences of this last-named disease were in fields of alfalfa.

The isolation of this fungus came so late in the year, and at a time when other matters were so pressing, that further work with it was, for the time being, impracticable. It is impossible, therefore, to predict its probable future value as an artificial factor in the control of the locust pest in the region where it was found.

The *Sporotrichum globuliferum* is reported as having been successfully used against the different species of destructive locusts in Algeria during 1899, but whether the identification of the fungus concerned is reliable is not known.

CONCLUSIONS.

After having spent considerable time in experimenting under various conditions and in different regions, as well as in the study of the researches carried on by others, it is the opinion of the writer that

the utility of fungus diseases in killing off insect pests is greatly over-estimated. Especially is this true with reference to their use against destructive locusts. The chief objections are the difficulties with which pure cultures are obtained and later transmitted to the insects to be destroyed, and the frequent adverse influence of climatic conditions.

Much of this false notion as to the absolute effectiveness of inoculation as a cure-all, which has gained a firm lodgement in the minds of so many people throughout the land, is, no doubt, due to the careless way in which agricultural and other newspapers of the country make definite statements on incomplete information. Then, too, very frequently contributors to such papers write concerning matters they know little or nothing about. This sort of business on the part of the press certainly places the economic entomologist in a peculiar position since it creates a misunderstanding between him and the people in whose interest he is supposed to labor.

Were the writer required to give his opinion as to which of these different fungi seems the most promising, he would, without hesitation, say, "The native one." He would say this, because the importation of these locust-killing fungi from one country into another depends greatly on the similarity which exists in the climatic conditions of the countries concerned, in the relationship of hosts to be considered, and in the ease with which the fungi can be handled in the laboratory. Between the *Empusæ* and *Sporotricha* the latter seem the more preferable, because they are more readily handled artificially, growing, as they do, quite readily on different culture media.

THE CONFLICT OF THE RUSSIAN ZYEMSTVOS^a WITH THE ENEMIES OF AGRICULTURE.^b

By V. MORACHEVSKI.

[Abstract by Dr. Peter Fireman.]

Not the measures employed by the individual farmer in his fight against the animals and insects injurious to agriculture are described in the present article, but those adopted by the local self-government organs in Russia.

GRASSHOPPERS (ACRIDIDÆ).

(a) *Pachytylus migratorius*. It is at present accepted as proved that the islands of some rivers (Ural, Volga, Kuma, Kuban, Terek, Manich, Egorlik, Don, Dnieper, Danube, and Sarpa) serve as nurseries for this insect. Such islands furnish an enormous store of food for grasshop-

^a Zyemstvo—A governmental body in Russian provinces and local districts, elected by the people. It consists in each case of a council and an executive board.

^b (Syelskoye Khozyaistvo e Lyesovodstvo (Agriculture and Forestry), vol. 193, 1899, April, pp. 183-208; vol. 194, 1899, August, pp. 193-226, September, pp. 445-454.)

pers, sufficient in the great majority of cases to maintain them from the time of their hatching to their death. Moreover, on these islands they are safe from their natural enemies. Therefore, the investigators of the grasshoppers, as well as some of the *zyemstvos*, have arrived at the conclusion that radical measures for preventing the calamities caused by the incursions of these insects must be directed not so much toward the destruction of the insects as toward the conversion of these islands into cultivated lands.

In the appearance of the grasshoppers in enormous numbers some periodicity has long been observed.

In the Taurida government some of the *zyemstvos* took up the combat against the grasshoppers in 1877. The rules which are at present obligatory in the contest in the whole province were elaborated by the provincial *zyemstvo* and confirmed by the Minister of the Interior. The work is paid for according to a scale fixed by the district *zyemstvos*. For the performance of the work all persons of the lower classes are required to present themselves (peasants, workingmen, and the like, not excluding the women and children above 10 years of age). Each relay of workmen can be held not longer than three days. The council of the district *zyemstvo* elects special organizers for stated sections of the district, whose duty it is to watch the appearance of the grasshoppers in the district, to study the extent of the area infested with the eggs of the grasshoppers, to keep the district as well as the provincial *zyemstvo* informed about their observations in this regard, and to personally participate and superintend the work of destroying the insects. In 1896 there were 17 such organizers in the Simpheropol district, with a compensation of 3 rubles per day during the time of fighting the grasshoppers.

The Bessarabia government began the contest in 1876 and stopped it in 1887, since when the grasshoppers have not appeared.

In the Kherson government the provincial *zyemstvo* conducts the fight against these insects as well as against others, and *sussliks* (*Spermophilus citillus*), covering the expense by collecting a tax of one-half cent per *dyessyatina* (2.7 acres).

In the Voronyezh government the provincial *zyemstvo* in 1882, in view of the fact that the grasshoppers deposited their eggs in the autumn over an extended area, especially in the Novo-Khopyor district, petitioned the Imperial Government to defray the expenses of fighting the grasshoppers from the general funds of the Empire, to appropriate for this purpose 1,000,000 rubles, and to impose a natural tax. Meanwhile the Novo-Khopyor district *zyemstvo* was directed to urge the land owners to plow up those places where the eggs were deposited. The Minister of the Interior, however, refused to grant to the provincial *zyemstvo* the subsidy of the Imperial Government, but agreed to loan that sum to the *zyemstvo*. In 1883 the grasshoppers made

their appearance in the spring. They were combated very energetically, with the cooperation of the police, local population, and six battalions of soldiers. At an expense of 52,000 rubles the *zyemstvo* destroyed completely the grasshoppers in the province.

In the Oryol government all the work directed to the destruction of the grasshoppers is divided between the provincial *zyemstvo* and the district *zyemstvos*, the duty of the former being the ascertainment of the places infested with the eggs of the insects, the instruction of the population in the methods of combating them, and a general supervision over the carrying out of all the operations, while the duty of the district *zyemstvos* is the immediate execution of those operations.

The Tambov government in 1893 petitioned the imperial administration to consider the destroying of the grasshoppers as a duty of the whole nation. The minister of the interior replied that similar petitions were received repeatedly from *zyemstvos*, but were invariably declined by the minister of the interior, with the concurrence of the ministry of finance, on the ground that, according to the existing laws, measures for the destruction of the injurious insects are incumbent upon the *zyemstvos*. The executive board of the provincial *zyemstvo* then organized the fight against the grasshoppers, a fund of 100,000 rubles being appropriated by the *zyemstvo*. The wages were fixed as follows: To a workingman with a horse, $12\frac{1}{2}$ cents a day; to one without a horse, 5 cents a day; for 36 pounds of grasshoppers collected, $12\frac{1}{2}$ cents.

The *zyemstvos* of the Ekaterinoslav, Chernigov, Kursk, Ryazan, Samara, and Penza governments had also to fight grasshoppers, which they did more or less successfully.

(b) *Caloptenus italicus* (Italian grasshopper). —This insect appears in some places in enormous quantities. In three districts of the Saratov government the peasants destroyed in one season 36,000 poods (1 pood = 36 pounds); on one estate alone during five weeks 15,000 poods were collected; in the Bobrov district 40,000 poods were destroyed.

In 1897 the following regulations were adopted by the Bessarabia government, with the approval of the imperial administration: A natural tax and a money tax are fixed. The natural tax is imposed on persons belonging to the lower classes (peasants, workingmen, etc.), not excluding women and children; all these persons must do the work of destroying the Italian grasshoppers, without compensation, within a radius of 7 versts (1 verst = $\frac{3}{8}$ mile); if called to more remote places they receive a certain compensation fixed by the provincial *zyemstvo*; each relay of workingmen can not be held longer than three days. The money tax is imposed upon all the landowners who are not subject to the natural tax. The money so collected goes to cover the expenses incurred in fighting the grasshoppers, in payment to the

owners for their crops destroyed, in payment of the workers who came from places farther than 7 versts, etc. For the crops destroyed while fighting the insects the owners are reimbursed to the amount of the value of the seeds, the cost of cultivation, and the rent for the land.

In the Orgueyev district, over an area of 2,000,000 acres, the fight against the Italian grasshoppers in 1897 required more than 26,000 adult workers, 20,000 boys, and over 2,000 wagons.

In the Kherson government the Odessa district *zyemstvo* spent in fighting the Italian grasshoppers in 1895, 4,000 rubles; in 1896, 20,000 rubles (paying to the workingmen 25 cents per day, young lads 12½ cents, to children 6¼ cents, and for man and wagon 50 cents, and 12½ cents, besides, for each pood of grasshoppers killed and collected); and in 1897, 9,500 rubles.

In the Taurida government the Dnieper district *zyemstvo* reports that the fighting of the grasshoppers pursued by it at a great outlay of money during three years is quite successful, as witnessed, among other things, by the considerable falling off of the expenses: The expenditures in 1894 were 37,000 rubles; in 1895, 9,000 rubles; and in 1896, only 2,760 rubles.

The Kursk, Ryazan, Voronezh, and Saratov governments fight the Italian grasshoppers by similar methods.

(c) *Gomphocerus sibiricus*, *Stenobothrus elegans*, *Stenobothrus melanopterus*, *Psophus stridulus*, *Bryodemus tuberculata*, *Stauronotus cruciatus* or *Stethophyma flavicosta*, *Stethophyma fuscum*, and *Pezotettix pedestris*.—These do much damage, chiefly in the east of European Russia, in the Ural region, and in western Siberia.

The *zyemstvos* of the Ufa, Vyatka, Perm, Nizhni Novgorod, and Kostroma governments conduct the fight against these insects on lines similar to those described with regard to the grasshoppers.

MEANS OF COMBATTING THE GRASSHOPPERS.

(1) Shallow reploting or harrowing in the autumn of those places which are infested with the eggs of the grasshoppers, etc., is one of the best and most effective measures. By shallow plowing, 2 to 2½ inches deep, the eggs are turned out to the surface of the ground and perish, partly from atmospheric conditions and partly from birds.

(2) Burning up by means of straw is practiced with great success to the destruction of the larvæ of the grasshoppers. The straw is usually piled up in the field in a few places; the larvæ gather to these piles toward evening in large numbers in search of drier places; the straw is then ignited simultaneously from all sides. In extreme cases, when it is too late to drive out the insects from among the crops, the crops themselves are burned up. For cereals thus destroyed the owners

receive from the *zyemstvos* an indemnity, which is usually somewhat less than the real value of the burned crop.

(3) The larvæ are sometimes destroyed by crushing with shovels, rolls, bundles of brushwood, etc. The brushwood drags give the best results. The laborers surround a certain section and drive the insects toward the center. When the circle becomes small a few brushwood drags are drawn along the circumference of the circle, describing circles of smaller and smaller diameter each time.

(4) The driving of the larvæ into ditches and destroying them there by crushing or burning is not effective in the case of adult insects or too young larvæ (the latter remaining immovable when the attempt is made to frighten them up by brooms, etc.). Protective ditches used for preventing the insects from passing over into the unattacked fields must be deep and well guarded to be effective.

(5) Collecting by means of bags, sheets, etc., is also much practiced. Certain trap bags have been invented and are very effective.

(6) Some apparently successful experiments were also made in destroying the insects by infecting them with the fungus *Empusa grylli*.

OTHER INJURIOUS INSECTS.

The *zyemstvos* have so far confined themselves principally to the combating of the *sussliks* and of the grasshoppers (including in the latter a number of allied insects), not taking up at all the contest against other insects equally injurious to agriculture, or taking it up only now and then, without regularity or system, in years of very great ravages.

(a) *Agrotis segetum* and *Agrotis exclamatoris* are the most dangerous and most common enemies of the winter cereals. Their caterpillars are usually called (in Russia) the winter worms. Against these insects a fight is conducted only by the *zyemstvos* of some northeastern governments—Kostroma, Perm, Kazan, and others. Only the provincial *zyemstvo* of the Kostroma government has imposed a natural tax. In this government peasants have to appear with plows, brooms, and shovels for two days; within a radius of 7 versts they get no remuneration, but beyond that distance a certain daily wage.

(b) *Anisoplia austriaca* (grain beetle).—The Imperial Government proposed in 1879 to all the southern *zyemstvos* to hold an extraordinary meeting in order to discuss the question of the grain beetle. All the *zyemstvos* (viz, of the Kherson, Poltava, Bessarabia, Taurida, and Kharkov governments, and also the Don *zyemstvo*) gave their opinions in favor of the mechanical methods of fighting the beetle, and petitioned the Imperial Government to prohibit the use of ropes and to declare the measures obligatory for all the southern governments. The Imperial Government granted the petition, making the following tax, as a temporary measure, obligatory for the enumerated govern-

ments during a period of two years: Persons of the lower classes must appear for three days' work without compensation at a distance of 7 versts and with compensation at a greater distance, not exceeding 20 versts; upon persons of the higher classes, on the other hand, a money tax is levied, the amount of the imposition per dyessyatina (2.7 acres) depending on the value of the work performed by the persons of the lower classes. The use of the rope was prohibited by the same law. After the lapse of two years the law was not renewed, each government conducting the contest according to its discretion. The Taurida and Ekaterinoslav governments leave the fight of the weevil to the population, and allow the use of the rope. The Kharkov government has imposed a tax of 1 garnts (2.88 quarts) of weevils from each dyessyatina (2.7 acres) under rye, wheat, and barley; for each garnts not presented a fine of 12½ cents is imposed.

The means of fighting the weevil employed by the *zyemstvos* are almost all mechanical: (a) Collecting the weevil with the hands or with specially designed machines, and (b) frightening off the weevils by means of a rope.

(c) *Cecidomyia destructor* Say.—The only measure enforced by the *zyemstvos* in fighting the Hessian fly consists in not allowing the early sowing of winter crops.

THE TOBACCO STALK WEEVIL.

(*Trichobaris mucorea* Lec.)

By F. H. CHITTENDEN.

In a consideration of the potato stalk weevil, *Trichobaris trinotata* Say., which was treated somewhat in detail in Bulletin No. 33, new series (pp. 9–18), it was remarked, in defining the food habits of this species, that tobacco and tomato appeared to be exempt from its ravages, although nearly all other Solanaceae growing within its range were attacked. Before the bulletin in question had appeared in print we received a communication from Mr. Lawson H. Shelfer, tobacco expert of the Bureau of Soils, and located at Willis, Tex., that a related species of weevil was greatly injuring tobacco in that section. Our correspondent first wrote in regard to this species, transmitting adults, and in the following months sent much material and many valuable notes on the habits of this insect and the nature of its ravages. The remarks which follow, on the insect's life history and habits, are based mainly upon Mr. Shelfer's letters and the material received from him.

The larva of this species also, as might be expected from its close relationship to the potato stalk weevil, inhabits the stalk of tobacco and also the main ribs of leaves, sometimes completely severing them or injuring them so badly that the winds which blow almost constantly in that region break them off and thus greatly weaken the plant.

This weevil first appeared, according to the testimony of residents of that vicinity, in 1898, and has become more numerous each year. At the date of first writing, May 20, from 2 to 6 beetles were found on single plants, frequently in pairs. It was concluded, as a result of conversation with many local growers, that the tobacco crop had been attacked even earlier than the specified date, but the cause was not definitely known.

May 28 some tobacco plants showing infestation were sent to this office. It was discovered a few days before this time that nearly every plant in a four-acre field was affected. In some neighboring fields it was impossible to find a stalk that did not contain one or more larvæ, but all fields were not so badly affected.

The larva is locally known as "pith worm," from its habit of boring through the length of plants.

The beetles were also stated to be doing great damage to tobacco.

June 12 Mr. Shelfer stated that the beetles were still cutting the leaves and depositing eggs. Owing to the fact that twenty-six days had elapsed at that time since rain had fallen and many nights were without dew, the tobacco crop suffered much, and more especially when this insect was at work in the stalks. During the last week of June and first of July we received considerable material from our correspondent, the insect being present in the three stages of larva, pupa, and adult at this time. In some stalks the pupal cell was constructed 4 inches from the root system, while in others on a level with the surface of the ground. It is evident that in tobacco this insect works in a different manner from that which it employs in other plants which it may infest, the reason being the very woody condition of the lower portions of the stalks. It is evident also that the larvæ, after attaining maturity or thereabouts, turn and bore upward for the construction of their transformation cells. The lowest individuals will mature first, and those which form their cells higher will mature much later. As a consequence there will be intervals of a week or more between the time of their transformation. Thus it happens that the older individuals must wait for the younger ones to make their exit, since there is hardly space for the former to pass the latter. Some of the insects penetrate to the very tops of the stalks.

Jamestown weed, which we have record of this insect attacking, was a comparative rarity in that section of Texas, and no other solanaceous plants could be found growing wild within half a mile of the infested fields. At other points (Liberty and Woodville, Tex.) this weed was found, but no weevils, this verifying an opinion hazarded by the writer that the insect was local as well as periodical as regards injuries.

Mr. J. A. Blohm, of Willis, verified Mr. Shelfer's account as to injuries of this stalk weevil, his experience practically duplicating that of our correspondent in most essential particulars.

Attack was at first attributed to improper farming.

September 5, 1902, Mr. Shelfer called at this office and furnished the writer with some additional information on the insect's occurrence and life history. Tobacco was first set out April 8, and the beetles were observed at work the following day, as a rule in pairs, attacking the leaves, which soon after attack began to droop. After the mid-ribs had been eaten for some time the leaves curled over, and under this protection the beetles congregated for feeding. The beetles, as well as larvæ, were still in the field the first week in September.

DESCRIPTIVE.

The tobacco-destroying species of weevil, *Trichobaris mucorea* Lee., may be readily separated from the potato species, *T. trinotata* Say, by its much larger size. The former will average one-fourth of an inch or a little longer (5-6^{mm}), while the latter does not exceed three-sixteenths of an inch, averaging about one-sixth inch or a little smaller (3-4.5^{mm}). The tobacco species is, moreover, a little more robust and of more uniform size, and is distinguished, according to Casey, "by its rather depressed upper surface and the subdentate area at the sides of the prothorax beneath." Also by the "pronotum densely and confluent punctate, sometimes longitudinally rugose, the sides more or less feebly sinuate just behind apical third; antennal club more slender and elongate, less abrupt, the outer funicular joints more transverse; pronotum with a narrow impunctate median carina."

In *T. trinotata* the pronotum is simply punctate and without an impunctate and subearinate median line, as in *mucorea*, and the antennal club is robust and abrupt. In a large series of specimens, such as the writer has at the present writing, it is seen that there is also a difference in color. All of the specimens of *trinotata* are darker, the pubescence being darker gray than in *mucorea*. There is no observable difference in specimens collected in the field and those taken from the stalks of eggplant the first week of September. In hibernated individuals of *mucorea* the scales are very pale, nearly white, while in those which have recently issued from stalks they are dull, somewhat yellowish brown." In all specimens of *mucorea* there is an apical line of yellowish pubescence on the thorax, forming a collar above the head. This collar is scarcely at all indicated in *trinotata*, and the color of the scales here is of the same uniform gray as of the entire upper surface.

INJURY IN FLORIDA BY A RELATED SPECIES.

July 14, 1902, Mr. William M. Corry, Quincy, Fla., wrote, in response to inquiry, that at various times in previous years—though not in

"This difference in coloration has been noted in another species of scale-covered weevil, *Ceutorhynchus rapæ* Say, Bul. 23, n. s., p. 43.

1902—he had observed affected stalks in fields of tobacco there, and when the leaves were broken off it was found that a hole was in the center, caused by a small insect known there as “the borer.” The insect seemed to start at the root and make its way gradually up into the heart of the stalk, its presence being indicated by the leaves dropping and the stalk gradually withering and turning yellow.

There can be no reasonable doubt that the species in question is *Trichobaris insolita* Casey, a species rather commonly found in that portion of Florida.

DISTRIBUTION.

In defining the distribution of the potato stalk weevil it has been said that that species was rather generally distributed throughout the Carolinian and Austroriparian regions, and that it was found westward to Texas. Such a statement has previously been made by Casey and probably others, and it may be that the insect really inhabits Texas, but in a series of 34 specimens at present available Texas-labeled individuals are not in evidence.

Trichobaris mucorea is represented in the national collection and others at present under observation by upwards of 50 individuals, from which the following locality list is taken: Columbus and Willis, Tex.; Los Angeles, Kern County, and elsewhere in California (no definite locality); Tucson, Galiuro Mountains, Santa Rita Mountains, Catalina Springs, and Oracle, Ariz. LeConte records the species from Cape San Lucas, Lower California, and there is little doubt that it occurs elsewhere in Mexico. The type specimen was found near Fort Yuma, Cal. (Proc. Acad. Nat. Sciences, Phila., 1858, p. 59.)

METHODS OF CONTROL.

In spite of the close relationship of this species to the potato stalk weevil, it is very evident that we have an entirely different problem to solve. The similarity of the insects is structural. The habits are materially different; for whereas the potato weevil has a definite time of appearance and disappearance, from April to May, and again the following year at the same time, we see no more of the insects until after they have laid their eggs and the larvæ have transformed to pupæ and thence to adults in the stalks. Here they remain during the winter. The tobacco weevil, on the contrary, evidently escapes from the stalks after the tobacco leaves have been cut, and hibernates in other places.

Paris green, Mr. Shelfer has observed, applied as a spray by means of a knapsack outfit, will kill the beetles, and he is of the opinion, in which the writer concurs, that if an arsenical is used at intervals during the season at the proper time, beginning with the time that plants are set out, the insect may be kept under control.

The following suggestions for another season are made:

After the leaves are cut the stalks should be destroyed as promptly as possible, and the entire fields should be cleaned of refuse; and this applies also to barns and other places where the tobacco is stored. If this be done systematically over the entire affected area it will leave very few insects to combat the following year.

The first appearing insects could be attracted and successfully dealt with, there is no doubt, by setting early plants as traps here and there over the area to be grown in tobacco. The growth of the plants could be stimulated, and they could be protected from insects and the weather until ready for use, by covering them with square frames covered with cheese cloth or similar material. A few days before planting the main crop the covers should be removed and the plants thoroughly coated with a spray of some arsenical.

Before setting out the main crop the plants should be dipped in a solution of arsenate of lead, prepared at the rate of 1 pound of poison to 100 gallons of water. This would not scorch the plants, and it would be preferable to Paris green, as it remains longer, requiring more rain to wash it off. In a week or ten days, according to the growth of the plant, a second spraying should be made, and for this purpose either arsenate of lead or Paris green and Bordeaux mixture can be used.

It is suggested by way of experiment that one plat of, say, 25 or more plants be sprayed with arsenate of lead; a second with Paris green, 1 pound to 150 gallons of water; a third with Paris green at the same rate, with the addition of Bordeaux mixture used instead of lime as a diluent; and the fourth, with Bordeaux mixture alone. It is not known to what extent Bordeaux mixture would prove repellent to this weevil (possibly not greatly), but if sufficiently distasteful it would drive the insects from the plants treated with it to others which should be poisoned with Paris green alone.

THE LEAF-MINING LOCUST BEETLE, WITH NOTES ON RELATED SPECIES.

By F. H. CHITTENDEN.

The foliage of the common yellow or black locust tree (*Robinia pseudacacia*) is subject to the attack of a leaf-beetle, sometimes called in literature the locust Hispa (*Odontota dorsalis* Thunb.) and which we may call the leaf-mining locust beetle to distinguish it from several other forms of insects, mostly the larvæ of Tineidæ, which also mine the leaves of this tree, and from other beetles which attack the trunk and other portions of the tree. Injury by the species under discussion is due mainly to the work of the larvæ, although the beetles also assist.

Damage usually becomes manifest some time in July in the more northern States, and southward earlier, in June. In cases of severe attack the leaves turn brown as if scorched by fire. Injurious attack is not often brought to the notice of economic entomologists, which is rather remarkable considering that the locust is of great value as a timber tree, for posts, etc., though of less importance as a shade tree than elm, oak, maple, and others with which everyone is familiar. Thus it happens that although year after year this insect has done much harm to the locust, where this tree is of value, comparatively little has been published concerning the insect's ravages, its life history and habits.

Like many other insect pests, it is subject to considerable fluctuation in numbers, in some years being quite destructive while in others it attracts little notice. It is nearly always more or less troublesome to the locusts in Maryland, Virginia, and the District of Columbia, and in recent years has been reported as more or less destructive in neighboring States. Injury has been reported in West Virginia from 1890 to 1897, in New York and New Jersey in 1896, in Maryland from 1896 to 1899, in Ohio and Kentucky in 1897, in Pennsylvania and Kentucky in 1898. These reports probably do not by any means sum up the entire area infested during the past ten years. In 1898 this beetle did more than usual damage over a considerable portion of this territory.

In most seasons this beetle does little more harm to the locust than to mar its beauty as a shade tree, but in years of its greatest abundance it is probable that trees are so badly weakened by the combined ravages of this and other leaf-miners that the result is practically the same as that of defoliation; the trees are so weakened that they readily succumb to disease, to unfavorable atmospheric conditions, and to the destructive work of different species of borers, such as the painted locust borer (*Cyllene robiniae* Forst.), a species which is of still more importance as an enemy of this tree.

In the vicinity of the District of Columbia the damage effected by this leaf-miner is frequently as bad as reported elsewhere, and we have observed locust groves where the injury was almost entirely due to the work of the beetle, while in others the Tineid leaf-miners were more numerous. As a rule, however, this locust beetle is more abundant about Washington than all of the leaf-mining Tineidae and other locust pests taken together, and its importance in economic entomology is deserving of a more detailed consideration than has hitherto been given to the public.

Injury is usually most severe to young trees and to such as have low, vigorous branches, and to others growing on the edges of sunny lawns and in similar locations. There are, however, some striking exceptions. In many localities such plants suffer greatly year after year. Taller trees, on the contrary, are much less subject to injury.

In speaking of damage effected by this leaf-miner, Chambers (Amer. Ent., Vol. III, p. 61) says:

The young trees seem to suffer most, as the insect seems to prefer their foliage; and large old trees seldom exhibit the burnt appearance of the young groves. Young shoots growing up around an old trunk will sometimes have nearly all of their leaves blistered, while few, comparatively, on the old tree will be injured.

DESCRIPTIVE.

Few species among our native Coleoptera exhibit more striking coloration than *Odontota dorsalis*,^a so that with the accompanying illustration (fig. 3, *a*) and description even an inexperienced observer can not fail to recognize it.

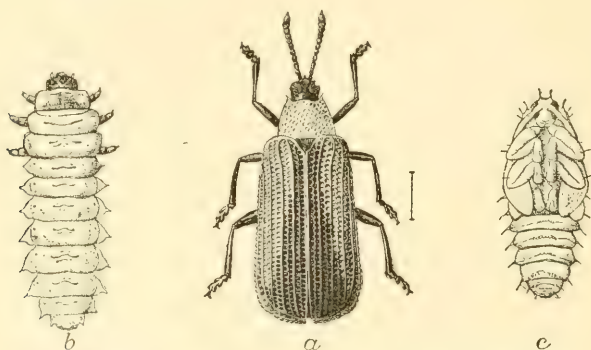


FIG. 3.—*Odontota dorsalis*: *a*, beetle; *b*, larva; *c*, pupa—5 times natural size (original).

The beetle.—Elongate in form, moderately convex, only moderately shining, the color of the dorsal or upper side being bright orange red with the head and a vitta or stripe along the suture of the elytra or wing cases black. The ventral or under side, including the legs, is also black. The black sutural vitta occupies usually about one-third of the width of the elytra and widens behind, but sometimes it is much narrower and of equal width and still more rarely widest at the base. The structural characters which, besides the coloration, distinguish *O. dorsalis* from other species of the same genus are as follows: Form rather slender, not cuneiform; elytra of equal width, each having ten series of punctures and three of the interstices forming elevated costae.

It measures a little less than a fourth of an inch in length (5–5.5 mm.) and is less than half that in width (2.2–2.4 mm.) at its widest part.

The egg is short, oval in outline and flattened on two sides, its color when freshly

^a As this species has been given other names than the one here used, a word should be added in regard to nomenclature. The specific name *dorsalis* was proposed first by Thunberg in 1805 (Götting Gel. Ang., p. 282); in 1808 Olivier redescribed it as *Chrysomela scutellaris* (Ent. Hist. Nat., Coleop. Vol. VI, p. 771), and Harris also described the species as new, using the name *Hispa suturalis*, which was first introduced by the Rev. F. V. Melsheimer in his Catalogue of the Coleoptera of Pennsylvania, published in 1806 (p. 15, no. 308), and seems to be based on an erroneous identification of our species with the *Hispa suturalis* of Fabricius.

laid being milk white, with the shell extremely thin and pliable. A very fine net-like sculpture is barely visible even under a strong magnifying glass.

The larva.—The more obvious characters by which the full-grown larva (fig. 3, *b*) may be distinguished are as follows:

Body depressed (but not flattened), elongate, very little tapering posteriorly, glabrous, color yellowish white, the head, larger portions of first thoracic segment, upper side of anal segment, and the legs brownish or blackish. Head subquadrate, about half as wide as the first thoracic segment, brown, shining, impunctate, with a deeply impressed median line. First thoracic segment more than twice as wide as long, a little longer than the head, distinctly bisinuate at the anterior margin, sides strongly rounded; a large brown spot divided by a narrow median line occupies the greater portion of the upper surface, but does not reach the posterior and side margins. Second thoracic segment a little shorter, but wider than the first, sides very strongly arched but not gibbous, surface uniformly whitish; third thoracic segment equal to the second. First abdominal segment a little shorter than the last thoracic one and also a little narrower, but produced on each side into a triangular, semitransparent tubercle, capped with a more horny point which in its turn terminates in a short spine. Second, third, and fourth abdominal segments equal to the first; on the following segments (which are slightly longer than the first) the lateral tubercle is directed gradually more backward; anal segment unarmed, shorter and much narrower than the preceding, subtruncate at tip, its upper side being of a brown color.

The general color of the dorsal surface is not uniform, but variegated by the transparency of the skin as the fat corpuscles of the body appear on the surface as yellowish-white spots, the rest of the body being grayish white. The sculpture of the dorsal surface (excepting head and anal segments, which are smooth) consists of a very regular fine granulation and besides this of vague impressions arranged as follows: On the first thoracic segment an undulating impression each side on the disk; on the two following thoracic segments a long transverse median impression accompanied each side posteriorly by a foveiform impression; on the abdominal segments a transverse median impression and another oblique one each side, causing the spiracles to be placed upon a kind of blunt tubercle.

The ventral surface is colored like the dorsal and only the head and median portion of the first thoracic segment are brown, while the general sculpture is like that of the upper side, legs being brownish or blackish, stout, and widely separated.

There are nine pairs of rather conspicuous stigmata, all visible from above and situated as follows: One pair at the anterior angle of the second thoracic segment, one pair on each of the first seven abdominal segments, each stigma being at the base of the lateral tubercle a little before the middle of the segment; the ninth pair is situated on the dorsal side of the anal segment. The thoracic and anal stigmata are larger than the intermediate ones.^a

^a It is interesting to observe that most leaf-mining larvæ of different families or even of different orders of insects exhibit a strong uniformity in general appearance, viz, a more or less depressed body, the head being much narrower than the first thoracic joint, while all joints of the body (excepting head and anal joint) are strongly arched at the sides and often tuberculate or even spinose. Thus the larvæ of our leaf-mining Buprestidæ (genera *Brachys* and *Pachyscelus*) and Rhynchophora (genus *Orchestes*) have an unmistakable resemblance to our Hispine larvæ, and all of these agree in shape with the numerous Tineid leaf-miners.

There can be no mistake about the number and position of the stigmata, and the account given by Chapuis & Candeze appears to be based upon a wrong interpretation of Harris's figures, entirely ignoring the correct description of that author.

The young larvæ differ from the mature ones by being more contracted, thus appearing more strongly tuberculate at the sides. Moreover, very young larvæ are entirely whitish.

The pupa (fig. 3, c) is at first whitish, but soon assumes a uniform rich honey color. In general shape it resembles the full-grown larva, though a little shorter and somewhat more convex. The head has become more convex and especially wider in comparison with the first thoracic segment; the second and third thoracic segments have of course changed the appearance of the wing pads, which are longitudinally striate and bent downward along the sides of the body, resting between the second and third pairs of legs and reaching with their extremities to the posterior end of the first ventral segment. The abdomen still shows the lateral tubercles so conspicuous in the larva and these tubercles are furnished each with two or three stiff bristles. The edges of the median transverse impressions on the dorsal surface of the abdominal joints of the larva are in the pupa much sharper, ridge-like, and also furnished with sparse bristles. The fourth abdominal spiracle is replaced by a long stout spine directed backward. On the ventral surface the armature of spines is even more conspicuous than on the dorsal, each segment having a sharply raised transverse line which is sinuate and more raised at the middle and there furnished with five or six setiferous tubercles. On the penultimate segment the transverse line is not sinuated and is furnished with eight tubercles, the two median ones being much less prominent than the lateral ones. The anal segment is also furnished with two obsolete transverse lines and with a few inconspicuous tubercles.

This array of bristles and tubercles enables the pupa to move rapidly forward or backward by a wriggling motion of the abdomen. The power of locomotion exhibited in this pupa is really astonishing; in fact, the pupa is much better afoot, so to speak, than the larva."

The mine produced by the larva has not hitherto been described so that it may be distinguished from the mines produced by the various leaf-mining Tineidæ which are usually working in company with it. As already stated, the beetle larva consumes the whole of the parenchyma within its mine, thus causing the mine to be equally visible on both sides of the leaf, whereas in the case of the Tineidæ the larva destroys only a thin layer of the upper portion of the parenchyma, causing the mine to be invisible on the underside of the leaf. The Tineid larva very neatly separates the epidermis from the parenchyma so that not a particle of this last is left adhering to the skin-like epidermis forming the roof of the mine, and this roof is of a uniform pale buff color strongly contrasting with the green of the leaf. On the other hand, the larvæ of the beetle accomplish their work much less carefully; numerous small particles of the parenchyma are left adhering to the epidermis, and consequently the latter forms a much thicker covering to the mine than in the case of the Tineidæ. The color of the mine is a pale greenslightly tinged with brown, its surface

"The power of locomotion in the pupa becomes still more remarkable if we take into consideration that the pupa, which always remains within the mine, has really no occasion or opportunity to make use of it, unless we except the possibility that by wriggling about in their mines the pupæ might succeed in evading parasitic or predaceous attack.

being lightly roughened and never so smooth as in the lepidopterous mines. In outline the beetle-larva mine is neither uniformly rounded nor provided with finger-like processes, but irregularly undulated. As soon as the larva has left the mine or has changed to pupa, the affected part of the leaf dries up and assumes the dismal brown color already alluded to.

GEOGRAPHICAL DISTRIBUTION.

This species is native to North America, and apparently partial to the upper austral life zone, but its full distribution does not appear to have been clearly defined beyond published statements that it occurs in New England and the Middle, Southern, and Western States. Northward, we know of its occurrence in Massachusetts, Connecticut, and Canada, but it does not appear to have ever been taken in Michigan, a State which has been rather thoroughly collected over by Messrs. Schwarz and Hubbard. In Missouri, although numerous collectors and observers have made collections in that State, the species appears to be rare, although taken in two localities. It will thus be seen that although the southern and western range is practically limited by the States of Virginia, Kentucky, and Missouri southward, and by Missouri also westward, the precise limits of its range remain to be determined.

In his Check List of the Forest Trees of the United States (Bul. 17, Div. Forestry, U. S. Department Agr., 1898, p. 82) Mr. George B. Sudworth speaks as follows regarding the distribution of *Robinia pseudacacia*:

Range.—From Pennsylvania (on the Appalachian Mountains from Locust Ridge in Marion County) to northern Georgia. Widely naturalized through cultivation and other agencies throughout the United States east of the Rocky Mountains; possibly indigenous in parts of Arkansas (Crowleys Ridge, etc.) and eastern Indian Territory; also in the Great Smoky Mountains of eastern Tennessee (Sevier County).

From the entomological record it would seem, therefore, at least at the present writing, that this locust Hispid has a more limited range of distribution than its food plant, a fact which is not infrequently noticed among insects and which obtains also in another species of Hispidæ, viz, the trumpet-creeper leaf-miner, *Ocotoma plicatula*, to be considered later on in the present article.

The following is a list of localities from which the species has been received at this office or is known to the writer or recorded:

Massachusetts; Connecticut; Allegheny, York, Pa.; Coney Island, Rockaway Beach, Yaphank, L. I., N. Y.; New Jersey (throughout the State—Smith); Tennytown, Washington, D. C.; Oakland, Bladensburg, Glen Echo, Cabin John, Marshall Hall, Md.; Cherrydale, Rosslyn, Va.; Monongalia, Wood, Hancock, Harrison, Upshur, Tyler, Preston, and Tucker counties, Morgantown, Kanawha, Clarksburg, W. Va.; southern Ohio, particularly Brown, Clermont, and Hamilton counties; Nazareth, Frankfort, Ky.; Cadet, Louisiana, Mo.; Indianapolis, Ind. (Blatchley).

INJURIOUS OCCURRENCES IN 1898.

Frequent inquiry has been made concerning this species and the injury committed by it, but it will be sufficient for present purposes merely to recount the occurrences of the year 1898 as an example of what is liable to happen any year.

May 10 beetles were observed in a raspberry patch at Tennallytown, D. C., feeding upon the upper surface of the leaves. July 1 we received a communication from Sister Marie, Nazareth, Ky., about injury to locust in that locality. July 22 Maj. Henry E. Alvord, of this Department, transmitted specimens of locust leaves from Fairfax County, Va., with accompanying statement that all locust trees over an area of several square miles in that county were at that time apparently dead, looking as if a fire had swept through the country, but without actually consuming the foliage. Major Alvord was interested to the extent of 300 acres, carrying a very large locust growth of considerable value. On this tract not a tree could be found, either old or young, protected or exposed, that was not in bad condition. The cause of the affection of the plants was not at first attributed to insects, but believed to have developed as a result of a recent period of exceptional dryness and heat, a remark which applies to much injury to locust that is caused by this leaf-miner. Ravages were so extensive, also, that it was practically out of the question to attempt any general remedy or means of prevention. August 1 we received from Mr. J. E. Herbert, York, Pa., specimens of leaves showing injury by this species and attributed to blight or rust. Injury was stated to be general along the Susquehanna River, in York County, where every locust tree seemed to be affected.

HISTORY AND LITERATURE OF THE SPECIES.

The natural history of the leaf-mining locust beetle was first made public in an article "Upon the Economy of Some American Species of *Hispa*," by Dr. Harris, printed in 1835 (Boston Journ. Nat. Hist., Vol. I, pp. 141-151), an account which, until comparatively recent years, constituted the only source of information regarding the early stages of the *Hispini*. It is noticeable that neither Harris nor subsequent authors of early times mentioned this species as particularly troublesome, the first instance of observed injury having been published in 1868 in an editorial answer to a correspondent of the *American Entomologist* (Vol. I, p. 58). The injury in question was at Frankfort, Ky., and it was stated that the beetles had eaten the leaves of black locust in that section so severely as to kill the trees in some cases, and generally to injure their growth and appearance. It was pointed out in the editorial reply that the principal damage was doubtless due to the insidious work of the larvæ in the pulpy internal sub-

stance of the leaf, rather than to the feeding of the beetles on the leaves.

The nature of the damage effected by this insect is well illustrated in an article which appeared in Volume III of the American Entomologist (pp. 59-61) by V. T. Chambers. Injury by this species is stated to have been rather general in northern Kentucky. "By the 1st of August the groves look as if a fire had swept over them; and on examining the leaves in many groves almost every leaflet will be found to contain a 'mine,' as the burrow of the larva is technically called, and many of them will contain three or four, while the imago or mature insect of *Hispia saturalis* will be found in great numbers feeding externally on the leaves."

About half of the injury was attributed to the leaf-mining locust beetle, the remainder to other species of leaf-miners.

The bibliography of this species has been brought together up to 1896 in Dr. Lintner's Twelfth Report on the Insects of the State of New York for that year (pp. 264, 265), and the subject need not be entered into here in detail. It should be mentioned, however, that the ravages of this species had assumed sufficient proportions in West Virginia to call for special investigations on the part of Dr. A. D. Hopkins, these studies having been begun in 1890, the results being published in a short article in Bulletin No. 16 (p. 87). In the Canadian Entomologist for 1896 (p. 248) the same writer mentions the destructiveness of this species in West Virginia, adding some new food plants, and in Bulletin No. 9, n. s. (p. 20), the junior author called attention for the first time to the fact that this species feeds also upon herbaceous plants, and that the larvæ develop in the leaves of soy bean. Other accounts, which appeared with and since the year 1896, contain little more than mention by State entomologists of ravages made by this insect in their respective States, all of which have been briefly brought together in the introductory chapter on this species. Exceptions are Dr. Lintner's article previously cited and a column article by Prof. E. D. Sanderson on page 672 of American Gardening for September 30, 1899.

FOOD PLANTS.

This species forms a rather interesting example of an insect with a well-known favorite food plant, which will also feed, even in times when this plant is available, on numerous other forms of vegetation, both related and otherwise.

The prime, and no doubt the original, food of the larva and beetle is, of course, common locust (*Robinia pseudacacia*), but there is no doubt that larvæ could develop equally well in the leaves of other species of the same genus, and perhaps of most other trees of the same family. On the grounds of the Department of Agriculture at Washington the

insect has been found in about equal abundance on various cultivated varieties of this locust, and the larva has also been observed in the leaves of false indigo (*Amorpha fruticosa*). Beetles are not infrequently met with upon various other trees, and more especially oak, but the larva has not been found until recently on any other plants than the two above specified. In the year 1880 this species was stated by Dr. John H. Warder (American Ent., Vol. III, p. 151) to be devouring the foliage of Siberian crab apples, and rendering it quite shabby, other forms of apple of the immediate vicinity escaping attack. The *Crataegus tomentosa* and some quinces appeared eroded in the same manner, and, although the insect was not seen, the injury was probably due to this species. The same correspondent mentions the young leaves of red oak (*Quercus rubra*) and European white oak (*Q. pedunculata*) as having been attacked, while nine or ten other species of oak observed escaped injury. It seems probable that the larva does not develop in oak, or in other plants outside the order to which the locust belongs, the Leguminosae. The leaves of *Ulmus americana*, or white elm, were also stated by Dr. Warder to have been eaten.^a The beetles have been observed by Dr. Hopkins (Bul. 32, W. Va. Agric. Ex. Sta., 1893, p. 202) attacking beech, apple, wild cherry, and Wistaria leaves; as also birch and hawthorn (Can. Ent., Vol. XXVIII, p. 248). During the summer of 1897 the writer observed this species feeding upon the foliage of red clover, which grew under locust trees upon which the larvæ had originally fed, on the leaves of hog peanut (*Falcata comosa*) growing under locust trees, while larvæ were found and reared on the large hairy leaves of soy beans on the grounds of this Department about 200 yards from where locust trees were growing (Bul. 9, n. s., Div. Entom., pp. 22, 23).

LIFE HISTORY AND HABITS.

The beetle. —In the vicinity of Washington the beetle makes its first appearance as soon as the leaves of the locust tree have fully developed, usually about the beginning of May, and is then to be seen without interruption throughout the summer, until the first half of September,^b being quite abundant from the first week of July to near the middle of August. During 1902 the beetles of the first new generation began to develop July 7 and had transformed for the most part by the 12th of that month.

The beetle is usually seen, apparently motionless, upon the surface of the leaves, but upon close inspection it will be found busily engaged

^aOwing to the confusion in the scientific nomenclature of our locust Hispid, these other records are not quite reliable, and may refer either to *Odontota rubra* or to *O. nervosa*, as these species are now known.

^bDr. Hopkins has recorded the occurrence of *O. dorsalis* in West Virginia as late as October 3, but does not state whether the beetles were feeding at this time.

in feeding. Early in the season, when the leaves are still tender, the beetle eats small oblong holes in the leaves, but later in the season it usually leaves the lower half intact and the upper portion finely skeletonized. At any rate, the damage done by the beetles, even when they are very numerous, is trifling when compared with that inflicted by the larva. The beetle is a slow walker and apparently dislikes to move about without cogent reason, but if disturbed it takes wing rapidly and is capable of sustained flight for long distances. During rainy weather, at night time, and during the act of oviposition the beetle is to be met with on the underside of the leaves.

Hibernation.—There can be no doubt that the perfect beetle alone hibernates. It seeks winter quarters rather early in the season, some time in September. During mild winter days a specimen may occasionally be found under accumulated leaves at or near the base of locust trees, but even for an experienced entomologist it is not an easy task to find them in their sheltered retreats.

Mode of oviposition.—Dr. Harris's description of the eggs of *Hispinini* (Treatise, etc., Flint ed., p. 120) does not apply to this locust beetle, and appears to have been made from dried cabinet specimens. The fact is that in our species the eggs are not laid on the upper side of the leaf but always on the underside, and, further, that they are not laid singly but in masses, each composed of from three to five eggs, which are glued together by a sticky substance and partially covered with an excrementitious secretion. We succeeded in July in partially observing the act of oviposition, which may be described as follows: One egg was already deposited, representing a somewhat flattened, short, oval object of yellowish-pink color fastened to the leaf by its flat side. The female beetle was quietly resting with the forepart of her body much erected and the last abdominal joints covering the egg, while the tip of the elytra touched the surface of the leaf beyond the egg. After a while the tip of the abdomen was bent toward the egg and a yellowish-pink semifluid matter was excreted; then an egg appeared at the genital opening, but was several times retracted and again protruded, when finally, with a sudden effort, the beetle moved its abdomen a little backward and deposited the egg so that with its end it rested upon the leaf and with its greater portion over the first egg. Then the beetle rested for about two minutes, when the same process was repeated. The act of oviposition itself takes only a fraction of a second. When the last egg has been laid the beetle makes a sudden movement forward, sweeping with the tip of the abdomen the upper side of the egg mass and discharging at the same time a large quantity of fluid fecal matter of dirty-yellow color, which soon hardens and darkens.

From this mode of oviposition the form of an egg mass can be readily understood. Since the second and the following eggs each overlap the preceding egg, but at the same time touch with one end the surface

of the leaf, it is evident that each egg is placed somewhat more vertically than the preceding one. But as there are never more than five eggs in a single egg mass, the last of these is still placed obliquely, and the egg mass when viewed from the side slopes very gradually in the direction toward the first egg while it ends more abruptly at the last one. Owing to the glutinous and excremental coverings the individual eggs can not be distinguished from above, but on the sides and from beneath, where the glutinous covering is very thin or absent, they may be plainly distinguished. The glutinous substance appears to possess some caustic properties, for the place of an egg mass can always be seen on the upper side of the leaf as a small brown spot. It hardens very rapidly, and becomes so tough and firmly adherent to the eggs that these can not be taken out from a mass without destroying them.

The duration of the egg state appears to be very variable, most of those which were gathered (in July) when apparently quite freshly laid hatching in from six to eight days, while others of the same batch hatched nearly a week later, but in every instance all the eggs of one egg mass hatch nearly at the same time, or at least within the space of a few hours, the first-laid egg usually hatching first.

The larva and its work.—The young larvæ invariably break through the egg shell on the underside of the egg mass and at once begin to gnaw through the epidermis of the leaf without leaving the protecting egg mass. Then they proceed to eat out the inside of the leaf, leaving only the epidermis of both sides of the leaf intact, thus forming what in scientific terminology is known as a tentiform mine. There is only one entrance to the mine, that made by the first-hatched larva, the other larvæ entering the inside of the leaf by the same hole. Thus from three to five young larvæ are usually found within the same mine, which rapidly grows through their united efforts. In fact, within a few hours four young larvæ had hollowed out about one-fourth of a large leaf, and it is evident that a single leaf is not sufficient to nourish the larvæ during their life duration. Moreover, the larvæ have the habit of hollowing out not more than one-half or at most two-thirds of a leaf. Thus in from two to four days after hatching (the time varying according to the state of the weather, the number of the larvæ, and the size of the leaf) the larvæ leave their original mine, wander off along the leaf stems, often to a considerable distance and to another twig, and form new mines, but this time each larva lives by itself. There are never two separate mines on one and the same leaf, and only once were two nearly full-grown larvæ found in the same mine. In captivity this process of migration was repeated as often as the leaves began to wilt, but we did not succeed in ascertaining the number of these changes in nature, owing to the difficulty in following the individual larvæ in their migrations, which appear to take place at night. This much has been ascertained, that at least

some larvæ change their habitation three times, but whether all larvæ have the same habit, or whether they change oftener than three times, is uncertain. However that may be, it will be seen that the damage inflicted by the larvæ is greatly increased by these migrations, for every leaf attacked is doomed to destruction.

The duration of the larva state appears to be quite variable. In captivity no larva was actually carried through from the time of hatching to pupation, but from observations in the field it is pretty clear that this period, even in the height of the season, is never less than two weeks, and probably lasts on the average three weeks, being somewhat longer in the beginning of the season than in midsummer.

The pupa.—The pupa state is assumed within the mine and lasts from six and a half to ten days, after which the perfect beetle breaks its way through the brittle epidermis of the leaf.

At 11 a. m. of August 5 a larva taken from its mine was found to have transformed to pupa within two or three minutes, the change having taken place while it was being taken from one room to another and returned. August 12 the imago was found fully colored early in the morning, the pupal period having been passed in about six and a half days. Temperature, 75°–80° F.

The number of generations annually.—This is a point in the natural history of the insect which has not hitherto been clearly made out. Dr. Harris (Ins. Inj. to Veg., Flint ed., p. 121) is evidently in favor of a single generation, and we have no doubt that this will hold true for the more northern States; perhaps elsewhere. In the latitude of Washington the insect, as has been stated, appears in May, one month earlier than in Massachusetts, and is then to be found in all stages throughout the summer, until the beginning of August, when egg laying ceases. It is therefore evident that individuals produced from eggs deposited early in the season developed to the mature insect early enough to produce a second generation in the same manner, but no second generation has as yet been segregated.

NATURAL ENEMIES.

Of nonparasitic enemies we have observed at Washington the wheel bug (*Arilus^a cristatus*), which appears to be particularly attracted by the presence of the *Odontota*.^b The young larvæ of the wheel bug may frequently be observed slowly walking over the leaves until they have found a mine inhabited by the *Odontota*. This found, the wheel bug deliberately pierces with its beak the *Odontota* larva through the

^a Formerly *Prionidus*.

^b The abundance of the wheel bug on the Agricultural grounds on the trees infested by the *Odontota* is in striking contrast to its comparative scarcity on the elm trees infested with the imported elm leaf-beetle (*Galerucella luteola*) and which are in close proximity to the locust trees.

epidermis of the leaf. Should a beetle be met by the wheel bug it is at once lifted in the air on the tip of the bug's proboscis.

In its earlier stages the leaf-mining locust beetle appears to be well protected from the attacks of true parasites, the eggs being inclosed in an armor-like covering, and the pupa remaining out of sight in the snug retreat of the mine, but still we have reared in a single season no less than four different species of parasites, and Dr. Harris mentions and describes still another species (*Ichneumon hispæ*) which has thus far remained unknown to us. These four species of parasites are as follows:

Trichogramma odontotæ How.—This species was reared quite commonly from the egg masses of this beetle. In cases of parasitism all the eggs of an egg mass were generally parasitized, and only in a few instances were two or three parasitized eggs found where the rest produced larvæ. The fly emerges usually from the underside of the egg and gnaws its way through the leaf. Dr. Howard described this and the other three species which will be mentioned below, in Volume I of *Entomologica Americana* (pp. 117–118).

Derostenus primus How.—A few specimens of this chalcis fly were obtained from the egg masses of the *Odontota*. The breeding of one of these species from the peculiar pupæ of a *Eulophus* would seem to indicate that it may in all cases be a secondary parasite, and that the specimens bred from the egg of the *Odontota* may have fed in the larva state upon the larvæ or pupæ of *Trichogramma odontotæ*.

Sympiezus uroplatæ How.—Upon opening the mines we observed in a few instances a whitish hymenopterous larva feeding externally on the *Odontota* larva and having already devoured the posterior half of its body. The host larva was of course dead when thus found. Whether or not this parasite in its earlier stage lives within the *Odontota* larva has not been ascertained. It appears to be very rare, and of the three specimens observed only one was raised to the perfect insect. It formed a naked black pupa within the mine.

Spilochalcis odontotæ How.—This parasite was observed emerging from the *Odontota* pupa, and no doubt lives as larva within that of the *Odontota*. The parasitized pupæ can be distinguished from the healthy ones by being darker and rigid. Upon opening such pupæ the parasite larva, apparently full-grown, was found to occupy the empty cavity, but the specimens thus disturbed died without changing to pupa. Only one winged parasite was obtained from a pupa which was left undisturbed in the mine.

The *Ichneumon hispæ* described by Harris was obtained by him from the pupa of *Odontota quadrata* (= *rosea*) and *O. scutellaris* (= *dorsalis*). It may belong to the Braconidæ. Harris's description was published in 1835 (*Boston Journ. Nat. Hist.*, Vol. I, p. 150).

REMEDIES.

From what has been said in regard to the feeding habits of the leaf-mining locust beetle it is obvious that whatever of a remedial nature is employed must be directed toward the beetles, since the larvæ are completely hidden in their mines in the leaves during their short lifetime, and the eggs and pupæ are similarly protected from contact poisons. The beetles can be killed by means of the arsenicals

administered in the form of a spray" in the same manner as for the imported elm leaf-beetle.

The leaves of locusts are so smooth that they are apt to shed an ordinary spray of Paris green, but this can be obviated by the addition of glucose or molasses to the spraying mixture, or by the more adhesive arsenate of lead. It should be unnecessary to state that the proper time to spray is upon the first appearance of the beetles in May or June, according to the localities infested, that the beetles may be destroyed before egg-laying commences.

Small groves can be protected by jarring the beetles from the trees into sheets prepared for the purpose and saturated with kerosene in the same manner as in use against the plum curculio and other beetles which drop to the ground and feign death when disturbed. The best time for this remedy is in the early morning, while the beetles are still somewhat sluggish. This method could only be employed with benefit before the beetles have oviposited, and with the coöperation of neighbors who possess similar trees, or in localities where the locust trees are isolated, not surrounded by others growing wild. This manner of collecting the beetles, to be effective, would have to be practiced every few days so long as the beetles continue to be attracted to the trees.

Where only a few trees in yards or lawns are to be protected, even more simple mechanical methods could be employed, such as jarring the beetles into inverted umbrellas and picking off the egg masses before these hatch. The egg masses are not difficult of detection and are sufficiently conspicuous by reason of their size and color to be easily seen by looking for them from beneath the branches toward the light.

In connection with any remedy that might be employed, clean culture must always be practiced, which includes the destruction of all volunteer locust growth in the immediate vicinity of trees planted for shade and ornament, and the prompt raking up and destruction of the locust leaves and other débris about the trees in the early autumn.

The protection of extensive woody tracts in which locust predominates is practically out of the question.

THE LEAF-MINING LINDEN BEETLE.

(*Odontota rubra* Web.)

This is also one of the species observed by Harris. He states that he discovered the larvæ in 1827 and afterwards feeding upon the

^a Instructions for the application of the arsenical poisons against the elm leaf-beetle are given on pages 3 and 4 of Circular No. 8 of this Division, as also on pages 10-12 of Farmers' Bulletin No. 99; and since both of these publications can readily be obtained by application to this Department, no further instructions need be given here.

parenchyma of a leaf of white oak. A description of the larva is given, with biologic notes (l. c.). Since that time this species (fig. 4) has been found to attack numerous other plants, and the writer has already expressed the opinion that the foliage of linden, or basswood (*Tilia americana*), is the favorite food tree. Larvæ and adults, the former mining the leaves and the latter feeding on the lower surface of the same, can be found in abundance at Ithaca and elsewhere in New York during the month of June, the imago occurring as late as September (Proc. Ent. Soc. Wash., Vol. II, pp. 266, 267).

Among other food plants are English filbert and orange, the imago having been found occasionally attacking the leaves of the last mentioned plant in Florida by the late H. G. Hubbard. It is more particularly, however, as an enemy to apple that this species has received mention by Harris (Ins. Inj. to Veg., 1863 ed., pp. 120, 121). Chokecherry (*Prunus virginiana*) is also recorded as the food plant by Harris, as also the shadbush or service berry (*Amelanchier canadensis*).

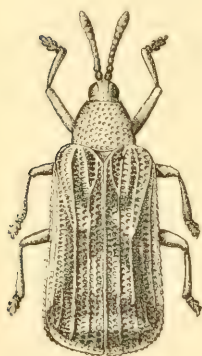


FIG. 4.—*Odontota rubra*: beetle—about seven times enlarged (original).

It has been called the rosy Hispa, from one of the Latin names (*Hispa rosea* Web.).

According to published statements the beetle makes its appearance during the latter part of May, and soon afterwards deposits its eggs on the leaves of the trees which form its larval food plants. The eggs are described as small, round, and of a blackish color, fastened to the surface of the leaf either singly or in groups of four or five.

In most respects the life history of this insect appears to resemble very closely that of the leaf-mining locust beetle. Fortunately it seldom occurs in abundance and has not often been reported, to the writer's knowledge, as having been the source of any considerable trouble. The experience of Mr. W. L. Devereaux at Clyde, N. Y., cited in the Fifth Report of the United States Entomological Commission (p. 480), that this insect is a very conspicuous pest in that vicinity, "destroying the entire foliage of every basswood in many forests except trees of great height," appears to be unique.

Concerning this species Mr. William Beutenmuller writes in 1890 that it "mines the leaves of apple and linden." The perfect insect may also be found on white birch, hornbean, cherry, Juneberry (*Amelanchier*), and *Pyrus arbutifolia* (Entom. Amer., Vol. VI, p. 178).

ODONTOTA NERVOSA *Panz.*

This common little species, which has also received rather frequent mention under its two synonyms, *inequalis* Web. and *rosea* Web., is

mentioned by Chambers (Canadian Ent., Vol. IV, 1872, p. 125) as mining the leaves of *Eupatorium ageratoides*, one of the bonesets.^a During the season of 1890 it was stated by Dr. Hopkins (Bul. 16, W. Va. Agric. Ex. Sta., p. 88) to be "found quite plentifully with the locust Hispa feeding upon the surface of the leaf [of locust]," while in Bulletin No. 32 of the same station (p. 202), the same writer states that this species is "very common on yellow locust leaves; also feeds on apple leaves," recording capture of the adults from April 30 to July 16 in Monongalia, Wood, Hancock, and Jackson counties. During 1902 the writer also observed it on locust in Maryland, and reared the beetles from mines in the leaves. There is also a Divisional record of the rearing of this leaf-beetle on a species of aster in the District of Columbia, July 29. September 1, 1899, Mr. Th. Pergande reared it also from *Cassia nictitans*.

A pale variety or race was found by Messrs. Hubbard & Schwarz feeding in great abundance on the leaves of *Robinia neomericanum* in the Santa Rita Mountains of southern Arizona during the months of May and June, but no trace of either eggs or larvæ could be seen on this plant.

ODONTOTA BICOLOR *Ol.*

This species is not rare in the District of Columbia and vicinity, but the writer has frequently sought for its mines on various wild plants without success. It remained for Mr. Th. Pergande to ascertain its true habits. The larva mines the leaves of grasses, Mr. Pergande having found it in the leaves of *Panicum macrocarpon* from June 18 to 26, 1899, at Cabin John Bridge, Md. The first beetle issued July 1. The beetles have been collected by the writer in greatest number during the second and third weeks of June.

ODONTOTA HORNI *Sm.*

Mr. H. W. Wenzel has found this species on *Cracca* [*Tephrosia*] *virginiana*, a papilionaceous plant commonly known as goat's-rue, at Da Costa, Atlantic County, N. J. (Ent. News, Vol. V, p. 41). It has been found also near Washington, D. C., on the same plant.

ODONTOTA NOTATA *Ol.*

This species was also taken by Mr. Wenzel on *Tephrosia-virginiana* with *O. horni* previously mentioned.

It is common near Washington, D. C., in Virginia, and the peninsula of Florida in localities where *Tephrosia* is absent. Mr. Schwarz thinks that the food plant will prove to be a species of *Solidago*.

^aMr. Beuttenmüller (Ent. Am., VI, 1890, p. 178) states that he reared this species from *Eupatorium* and asters.

ODONTOTA CALIFORNICA *Horn.*

The larval food plant of this species, *Ceanothus integerrimus*, has been placed on record in Volume V of Insect Life (p. 269) from rearings made by Mr. Coquillett while agent for this office in California. He found it mining the leaves of this plant, and reared the adult in September.

A Chalcidid was also reared from the larvæ of this species.

ODONTOTA SCAPULARIS *Ol.*

Nothing appears to be recorded of the food habits of this species further than that it was captured on a species of hazel (*Corylus*) in Kansas (E. A. Popenoe, Trans. Kan. Acad. Science, Vol. V, 1877, p. 36). The beetle has also been taken on *Solidago* in and about the District of Columbia, but the larvæ have apparently not yet been identified.

MICRORHOPALA VITTATA *Fab.*

This is one of the common species which are to be found northward, and was observed by Harris in 1833 on the leaves of *Solidago "laevigata"*—*sempervirens*, or seaside golden-rod. The account in question includes a description and figure of the larva, as also the mature beetle. What were presumed to be the eggs were also described.

The larva, which has been observed on other species of *Solidago*, including *lanceolata* and *canadensis*, forms blister-like mines in the leaves much like those of other species of the same group. This insect appears to be most abundant upon plants growing near the seashore and along the river banks, and is quite abundant along the coast of Massachusetts, Long Island, and New Jersey. It is common but not nearly so abundant along the Potomac River and its branches in and near the city of Washington.

The eggs have been found near the tips of the leaves on the lower surface. They were covered with a brown substance evidently excremental, and mixed with the hairs of the leaf.

A female was noticed which had just deposited two eggs, May 13, at Rosslyn, Va. She was at this time quietly resting, head downward with the tip of her abdomen just touching the eggs.

This species has also been found parasitized by a Chalcidid.

MICRORHOPALA XERENE *Newm.*

This attractive little species occurs in considerable abundance in the vicinity of the District of Columbia and has been given some study by the author. It appears to have a somewhat greater diversity of food habits than the innoxious species which have been previously con-

sidered, this being especially true of the larva, which has been found mining the leaves of several genera of Compositæ, although different species of golden-rod appear to constitute its principal food. The plants upon which the larvæ have been observed to make their mines and from which the beetles have been reared include: *Solidago canadensis*, *cæsia*, *juncæ*, et al.; *Boltonia asteroides*; *Sericocarpus asteroides*, or toothed white-topped aster, and several species of the true aster, or starwort. So far as observed, this species has confined its attacks to wild plants, but as the *Boltonia* mentioned and many asters are cultivated it will probably be found to attack some of these in time.

The beetles eat out little elliptical holes in the leaves of their food plants after the manner of the commoner *M. vittata*. Frequently three or four beetles have been observed crowded closely together upon a single leaf of golden-rod. In such cases they sometimes nearly strip the leaf attacked. What is true of the beetle is equally true of the larvæ. Unlike the locust-mining species, as many as four larvæ can develop in a single large leaf. June 24 four pupæ of normal size were found together in a leaf of *Solidago cæsia*, the mine occupying about three-fourths of the apical end of the leaf.

It would be a difficult matter to describe the mines accurately, as these are so variable and, as previously stated, sometimes occupy a very considerable portion of a leaf. The mine, at the point where the pupal cell is formed, puffs up so as to form a hard blister, more or less rounded oval in shape, usually a little over an eighth of an inch wide, which sometimes becomes as thick through, its dimensions being dependent upon the number of individuals which inhabit it.

The eggs, as might readily be inferred from the smaller size of this beetle, are not so large as those of other species which have been described. They are very closely appressed to the surface of the leaf on which they are deposited and are covered with dark, nearly black, excrement, sometimes all the eggs of a group which are placed closely together being covered with a common coating. The eggs are usually deposited on the lower side of a leaf, but in one instance a batch of five eggs were found on the upper surface. Most frequently they are placed near the edge, sometimes midway between the tip and the base of a leaf, but generally above the middle.

The larvæ possess the same power as do those of the locust-inhabiting species of passing from one leaf to another, and larvæ in confinement have been seen in the daytime crawling out of a leaf and re-entering in a fresh place. Larvæ have been noticed to forsake their mines when the leaves were not in a condition that was entirely to their liking. Such desertion of mines was observed on one occasion. June 16 all of the larvæ transforming to pupæ, and, in due time, to adults, the first imago appearing June 24.

The pupal condition was observed in three individuals during the last week of June, in hot weather, and lasted four and a half, five, and five and a half days, respectively. From finding several pupal cells as early as June 10, it was evident that the first of the new brood, or generation, of beetles begins to appear at least as early as that date.

The larvæ and pupæ resemble in a general way those of the preceding species and no detailed descriptions have been made. The larva when full grown measures from 6 to 6.5^{mm} and the pupa about 5.5^{mm}. It was noticed that the pupæ moved by elevating the abdominal segments and bringing forward the last segment, thus giving a forward impetus. The pupæ moved slowly, however, at the rate of about 1.5^{mm} at each step (if this expression can be used to describe the motion) which is as fast or faster than the pace of the larvæ. Pupæ were noticed to make as many as twenty consecutive movements.

No less than four distinct parasites have been reared from this leaf-miner about the District of Columbia. All are Chalcididæ, and the list is as follows:

Eurytoma albitarsis Ashm., from mines in *Solidago*.

Closterocerus tricinctus Ashm., from a mine in *Sericocarpus asteroides*.

Tetrastichus microrhopalæ Ashm.—A large series was raised from the dried larval skins, July 7–14.

Mesocrina microrhopalæ Ashm.—A single example reared July 6 from a white cocoon in a mine of this beetle.

A single example of the beautiful little *Hippocephalus multicinctus* also issued from mined leaves, but may possibly have bred from some species of Tineidæ as this Chalcidid is known to live parasitically on this order of insects and has not been observed to attack Coleoptera.

MICRORHOPALA MELSHEIMERI Gr.

Mr. Henry Ulke found a specimen of this beetle in an ant's nest at Pen Mar, Pa., but it is probable that this was an accidental capture. (Proc. Ent. Soc. Wash., Vol. I, 1890, p. 248.)

MICRORHOPALA FLORIDANA Schwarz.

This species was reared by Messrs. Hubbard and Schwarz at Crescent City and Bartow Junction, Fla., from larvæ found mining in the terminal portion of the leaves of grass-leaved golden aster (*Chrysopsis graminifolia*).

OCTOTOMA PLICATULA Fab.

The Virginia creeper, *Tecoma radicans*, has been known as the food plant of this species (fig. 5) since about 1879, but was not placed on record until 1890, when a short note was published in the Proceedings of the Entomological Society of Washington (Vol. I, p. 232). The larva makes a tentiform mine in the leaves of this plant, and the imago eats

oblong holes in the leaves. It is somewhat remarkable that the food habits of this species had been overlooked, as far as published records go, until that time, considering that the insect is widely distributed and frequently found in large numbers. The plant has a still wider distribution than the beetle, which is proved by failure to find it upon this plant in Michigan and in central and southern Florida, as well as in other localities. Even in the vicinity of the District of Columbia the species is local and not to be found wherever its food plant occurs.

May 25, 1879, the habits of this species were first observed by Mr. Schwarz at Columbus, Tex. It was noticed that a pupa was always to be found in a pocket adjoining the midrib. The beetle feeds also on the plant. The mines consist of several sinuous branches starting from the midrib, these branches being of varying length and shape. At the end toward the base of the leaf there is usually an oblong, or nearly oblong, blackish spot, presumably where the egg has been deposited and where the excrements of the larvæ collect.



FIG. 5.—*Octotoma plicatula*; beetle—about seven times natural size (original).

OCTOTOMA MARGINICOLLIS *Horn.*

The perfect beetles were found by Messrs. Hubbard and Schwarz in great numbers riddling the entire foliage of certain small ash trees in Madera Canyon, Sta. Rita Mountains, in southern Arizona, during the months of May and June. Neither eggs, larvæ, nor larval mines were seen on the trees at this season, and it would seem that the real food plant of the species is a vine or some other plant which makes its appearance only after the beginning of the rainy season toward the end of July or in August.

STENOPODIUS FLAVIDUS *Horn.*

From various structural details of this genus, Dr. Horn suspected that the habits of the only species would prove to be subaquatic. While nothing definite has been ascertained regarding the larval habits, the imagos have been found in various localities remote from any water, and under conditions which strongly suggest the larval food plant. Near Brownsville, Tex., Mr. Townsend and Mr. Schwarz found a number of specimens on a malvaceous plant which appears to belong to the genus *Abutilon*.

GENERAL NOTES.

ERRONEOUS BELIEF THAT COMMON NATIVE INSECTS ARE INTRODUCED FROM ABROAD IN SEED.

Every month or two during the warm season we receive communications from farmers in various portions of the country, more particularly in the more sparsely settled States where new crops are being cultivated, concerning the probable introduction from abroad of many common species of insects in seed furnished by the United States Department of Agriculture and experiment stations. Such a communication was received from a correspondent in Texas who had never seen the Colorado potato beetle there before, although the insect has been present in that State since about 1882, and probably earlier, with the remark that it was supposed to have been introduced with seed potatoes from Minnesota. May 27, 1902, another correspondent at Gainesville, Cook County, Tex., wrote in regard to the striped cucumber beetle, which he believed had been introduced with seed received from this Department. In response to inquiry as to particulars, he wrote, that although for twenty-five years he had had experience each year with nearly all the vegetables named in circular No. 31 as food plants of this beetle, he had never seen the insect before, and thinks it impossible for it to have been present on his plants without his having noticed it. Neither had any of his neighbors taken notice of this insect. It seems to have first appeared there in destructive numbers in 1902.

CAPTURE AND POSSIBLE INTRODUCTION OF THE NUN MOTH IN AMERICA.

On the occasion of a visit to Washington by Dr. W. J. Holland, a well-known authority on Lepidoptera, he mentioned the fact that the nun moth (*Psilura monacha* Linn.)^a had been obtained from a collector in the vicinity of Brooklyn, N. Y. Mr. George Franck, an experienced collector of that city, was referred to as authority, and in answer to an inquiry for the particulars of the capture of this insect, he wrote substantially as follows: In looking over a small collection of a local collector during the summer of 1901, he found, among other material, five individuals of this species, identified by comparison with European specimens of which he possessed a number. The collector in question had no communication with others than Mr. Franck, from whom he obtained material in exchange. He was questioned regarding this species and its occurrence, and Mr. Franck was assured that the specimens had been captured at light in Brooklyn. No other person who had been consulted in regard to this species knew anything of its occur-

^aAlso frequently mentioned in literature as *Liparis monacha*, and recently placed by Meyrick in the same genus as the gypsy moth, *Ocneria*.

rence in that vicinity, and it was put down as an accidental importation, which is probably the truth. The collector resides in a district where there are numerous lumber yards, and shipping is carried on to a great extent. The exact location is described as being around North Second street and Metropolitan avenue, near a creek which adjoins that portion of the bay running through the eastern part of Brooklyn.

As only five of the insects were captured it does not necessarily imply that the species has been introduced, but we may have here a parallel case to that of the gypsy moth, which was known to have been actually introduced in this country twenty-five years before it attracted the attention of economic entomologists. As the two species are related and have similar habits, there is reason to believe that if the nun moth does become permanently located in the vicinity of New York, it will prove a national calamity, and more troublesome even than the gypsy moth, as it will be difficult to deal with the pest in such a locality. The gypsy moth is established inland, while the nun moth, if it has obtained permanent foothold (which may not be ascertained for a number of years), will probably have spread to the immediate vicinity of waterways on either side. It is a matter that should be made public at once, that all persons interested in entomology and in agriculture may be warned to keep a sharp lookout for this species during the coming years. The Division of Entomology should be notified of captures of anything suspicious, and any insect suspected of being the nun moth should accompany the letters.

ESTIMATED LOSS OCCASIONED BY THE VARIEGATED CUTWORM IN 1900.

In looking over accounts of injuries recently occasioned by various well-known species of noxious insects, the writer noticed the lack of reliable estimates of money losses sustained. The question of the extent of the damage due to the ravages of the variegated cutworm (*Peridroma saucia*) in 1900 was entirely lost sight of by the writer as well as by others who published in regard to injuries.

Occasion was therefore taken, in writing Dr. James Fletcher, Dominion entomologist of Canada, to make inquiry in regard to injuries in the Dominion. Through him we obtained information from Mr. J. R. Anderson, deputy minister of agriculture for the province of British Columbia, as follows: "Replying to Mr. Chittenden's inquiry as to the loss from the variegated cutworm last year—from all the information obtainable and making an addition for unreported districts, the losses foot up to \$168,000."

Next, Prof. C. V. Piper was written to in regard to damage inflicted by this cutworm in the State of Washington, and he obtained from Mr. David A. Brodie an estimate of \$1,012,500 in western Washington, this being based upon the estimate of damage in British Columbia. In commenting on this, Professor Piper stated that he could well believe

the loss in Washington to be ten times as great as that in British Columbia, that is, \$1,680,000.

In Oregon, Prof. A. B. Cordley, entomologist of the experiment station at Corvallis, placed injuries at the modest estimate of \$50,000.

If to the estimated damage in British Columbia we add the injury which was accomplished in the Provinces of Ontario and Manitoba, there will be no difficulty in raising the figures for the Dominion to \$200,000. Then it must be remembered that isolated instances of injury were also reported in various States, for instance, in California, Texas, Missouri, Kansas, West Virginia, Illinois, Maryland, Virginia, and the District of Columbia. Taking all data into consideration, accounting for many localities from which no reports were received, admitting that this species was undoubtedly responsible for much injury merely attributed to cutworms in general and not reported to any official entomologist, also that it is cosmopolitan and practically omnivorous, it would seem that an estimate of \$2,500,000 would not be too high as the total cash value of crops injured in the United States during the single season of 1900.—F. H. C.

OCURRENCE OF THE MEDITERRANEAN FLOUR MOTH IN MINNESOTA, WISCONSIN, AND MICHIGAN.

During the past two years several complaints have been made to this office of trouble occasioned by the presence of the Mediterranean flour moth (*Ephestia kuehniella* Zell.) in flouring establishments and warehouses in Milwaukee, Wis.; in Minneapolis, and neighboring cities in Minnesota; and quite recently in Detroit, Mich. Through other sources of information we have knowledge of the insect spreading to neighboring States and being further disseminated in other States where it has already been established for some time; in fact, it is apparent that it is now only a matter of a few years when this insect will become permanently established in most portions of the Union where milling is an important industry. All communications were accompanied by specimens, usually with all stages of the insect, in infested flour webbed up in the manner characteristic of this species.

February 23, 1901, Mr. George W. Peckham wrote of the injurious occurrence of the pest at Milwaukee, Wis., transmitting material received from a gentleman largely interested in flour mills in that vicinity who had experienced a great deal of trouble with it. April 20 Mr. Harry D. Cushman, Minneapolis, Minn., stated that although he was not aware that mills in that city were badly infested with this moth, he understood that some mills in Superior had to close because of infestation. The modern system of keeping the mills scrupulously clean, not permitting dust or dirt to accumulate, and the turning of the stock of grain and its products every few days, had eliminated to a

great extent the trouble that had previously been experienced. Our correspondent believed that this statement would apply to the larger mills, at least, of his locality. November 20, a correspondent at Balls Ferry, Shasta County, Cal., reported this flour pest in that vicinity. This appears to be a new locality in California, although the species is rather more widely distributed there than in any other State of the Union.

January 28, 1902, the president of a flour company at San Francisco, Cal., wrote in regard to the Mediterranean flour moth in that city. In putting up breakfast cereals his firm had been seriously annoyed by the eggs and larvæ of the moth developing several weeks from the time of packing. He said that the food material in question could be exposed to a temperature of 212° F. or thereabouts without serious damage. June 30 a merchant miller, of Detroit, Mich., sent this species in flour from a mill in that city. He was anxious to obtain information in regard to the use of hydrocyanic-acid gas, as the insurance companies refused to grant permission for the use of bisulphid of carbon as a fumigant. Two years earlier it was reported that one mill in Detroit was infested by this insect, and it was surmised that the present invasion was due to the introduction of wheat or secondhand bags from the Northwest, with little doubt from Milwaukee and Minneapolis, where this species as just reported is now known to be present in great numbers. It is now said that nearly all the mills in those two cities are completely overrun with this pest.

THE ANGOUMOIS GRAIN MOTH IN 1901.

In spite of the employment of precautionary as well as remedial measures that have been generally used against the Angoumois grain moth (*Sitotroga cerealella* Zell.) in the more northern States in which it is found, it continues to be injurious year by year, and it seems to be as troublesome now as ever, if, indeed, not more so. The following notes are extracts from correspondence during the year 1901. In nearly every instance specimens of the insect accompanied the letters.

February 8 we received word from the Larrowe Milling Company, New York City, that this species was a general pest throughout New Jersey and eastern Pennsylvania.

On the 27th of the same month Mr. James R. Kirby, Smiths Grove, Ky., wrote that the farmers of that vicinity were seriously troubled by this species.

March 4 Mr. William J. Haverly, Los Angeles, Cal., complained of injury to the seeds of field corn.

September 28 Mr. Horace L. Dilworth reported this species as doing great damage to wheat in the neighborhood of Centerville, Del.

October 17 Mr. Walter Geist, Shawan, Md., who runs a thrashing

machine, stated that in some places in that vicinity grain was very badly infested.

November 13, 1901. Mr. C. S. Scofield, of the Bureau of Plant Industry, exhibited specimens of wheat badly infested by the Angoumois grain moth, received from Mr. Charles Dunwoody, Philadelphia, Pa., who stated that his firm had handled through its warehouse about 30,000 bushels of this year's crop which showed the work of this insect. It was noticed that the insect had been gradually working a little farther west each year. Early threshing had been the principal remedy employed. All varieties of winter wheat and rye appeared to be infested alike. The ravages of this insect had first been noticed about four or five years previous to the date of writing, and had been increasing from year to year since. Mr. Dunwoody stated that the greatest damage was at that time reported from the counties of Delaware, Chester, and Montgomery, in Pennsylvania; as well as in some sections of western New Jersey. Nearly two-thirds of the grain in the regions mentioned appeared to be infested, and it was estimated that the damage was about 20 per cent of the value of infested lots. Mr. Dunwoody asserted that field-threshed grain is seldom infested, but that nearly all grain which goes through the "sweat" in barns is more or less affected.

From Rev. J. F. Sheppard, Conshohocken, Pa., we received information, under date of November 29, that this insect was ravaging granaries in that vicinity.

December 19 Mr. Theodore C. Search, Philadelphia, Pa., reported that this species was very destructive to the wheat crop of Bucks County, Pa. In a badly infested sample from Chester County, Pa., he stated that the wheat weighed only 38 pounds to the bushel, and was worth for feeding purposes 60 cents per bushel of 60 pounds on our present market. This same variety of wheat, if sound and in good condition for milling purposes, would bring 78 cents. Later he wrote that one reason why the Angoumois grain moth is so destructive in certain portions of Pennsylvania is the fact that in the vicinity of Philadelphia the farmers *prefer to thresh their grain during the winter season at odd times*.

In one sample of wheat from Pennsylvania infested by this moth many specimens of a parasite occurred; in fact, in this lot the moths were almost completely killed off, only one breeding out in the course of three weeks, the parasites occurring in the proportion of something like 50 to 1. The parasite having a somewhat novel appearance, it was referred to Mr. W. H. Ashmead, of the National Museum, who states that it is undescribed. It is a species of *Catolaccus*.

RECENT INJURY BY THE CIGARETTE BEETLE.

More complaints were received of injury by the cigarette beetle (*Lasioderma serricornis* Fab.) during the seasons of 1901 and 1902 than

ever before in its history; judging by correspondence, this insect is rapidly widening its range, and unless radical measures are taken by the individuals whose products suffer from its attack, the insect will undoubtedly continue to increase and spread and will soon become a species of the highest economic importance. Complaints of injury were received from different firms, mostly tobaccoists, wholesale and retail, in New York City; Baltimore, Md.; District of Columbia; Danville, Va.; Cincinnati, Ohio; Detroit, Mich.; Porto Rico; and Kingston, Jamaica. The insect was the subject of considerable correspondence from the localities mentioned. In most cases destruction was to tobacco, but certain other products were affected.

During February we received complaint from one of Cincinnati's largest department stores of injury to cigarette tobacco. September 21 a manufacturer and importer of cigars in New York City complained of this species, stating that the beetles were in every can of tobacco received from a certain firm. They were eating through the wrappers of cigars. October 10 complaint was made of considerable injury by this insect to upholstered furniture in department stores at Detroit, Mich. The insects were stated to be infesting the very best furniture in one house. In the latter days of October Mr. Frank D. Gardner, agent in charge of the experiment station at Porto Rico, stated that cigar dealers in San Juan had considerable trouble in keeping their stock for any length of time on account of the cigarette beetle boring holes in the cigars and practically ruining them. November 13 a cigar dealer at Baltimore, Md., stated that his firm had lost about 700 of their best cigars through the attacks of this insect.

During July, 1901, complaint was made by a large wholesale and retail tobacco establishment in the city of Washington of injury by this beetle, and an opportunity was afforded for disinfecting the establishment infested by means of bisulphid of carbon. This work was undertaken by Mr. W. E. Hinds, temporary assistant in this Division. The results of these experiments, which were eminently satisfactory, were published in Bulletin No. 30, new series, (pp. 78-82). This led to a further study of carbon bisulphid as an insecticide and to the treatment of this topic in a general manner. The results of further study and investigation have found expression in Farmers' Bulletin 145, prepared by Mr. Hinds with the cooperation of Mr. E. E. Ewell, assistant chemist of this Department. The cigarette beetle was also found by Mr. J. Kotinsky, of this office, in a pharmacy at Washington, D. C., affecting American saffron.

January 23, 1902, complaint was received from a prominent cigar manufacturer of New York City of injuries by this insect. April 9 Mr. H. H. Cousins, island chemist, of Kingston, Jamaica, requested information on dealing with the cigarette beetle, which he stated threatened the tobacco trade of Jamaica.

In practically all of the instances of attack that have been mentioned letters of complaint were accompanied by specimens of the insects at work in tobacco or other products affected.

INJURIOUS OCCURRENCE OF AN EXOTIC DERMESTID IN THE UNITED STATES.

Among the beetles of the genus *Dermestes*, treated by Dr. Horace F. Jayne in his paper entitled "A revision of the Dermestidae of the United States" (Proceedings American Philosophical Society, Vol. XX, 1883, p. 353), *D. cadaverinus* Fab. is included, Florida being given as its only locality. Correspondence during September, 1901, shows not alone that this species is apparently established in this country in New York City, but that it is probably an exotic form, perhaps originating in China.

September 6, 1901, the Clifton Silk Mills, town of Union, N. J., sent specimens of this species, with accompanying information that the beetles and their larvæ were found in bales of dried China silk-worm cocoons imported from Shanghai for reeling. Many of the beetles were noticed at this time wandering about among the cocoons, and a lesser number of larvæ. A friend of our correspondents having a silk-reeling establishment in France said that this (or perhaps a related) species emerged from the cocoons when the latter were kept in moist places. Another friend interested in silk culture stated that he found the larvæ or "worms" in bales of reel silk, and that they cut the silk as with a knife, establishing themselves generally beside the cords which tie the bundles, and working their way along the grooves made by the cords, cutting the skeins as they go. He recollected that larvæ had been occasionally found in Italian silk.

Our correspondents stated that the beetles made short flights, but were disinclined to use their wings.

September 14 our correspondents called attention to the small clean holes made by the insects in the cocoons, in contrast to that made by the silkworm moth, which in emerging makes a ragged hole, stained brown for some distance in from the edges. It was further stated that in France, where this species is found in reeling establishments in raw silk, that when the packing of the silk was done near where the cocoons were stored infestation was noticed. By removing the packing department to a distance from the cocoons this trouble was averted.

September 25, 1901, the Payne Spring Tanning Company, Cumberland, Md., sent specimens of this beetle with sample of leather received from a tanner in New York City, showing holes through which the beetles had bored. Our correspondents stated that the leather was rolled in bundles of 12 and 24 sides each, and upon opening the same they found that the leather had numerous holes in it about the size

that would be made by large shot. According to their description, the beetle or its larva would start on one side and cut a hole through an entire bundle of leather. An attempt to disinfect the leather with carbolic acid had no apparent effect.

Writing again September 28, this company stated that there was little doubt that the leather became infested in a hide house in New York City where it had been stored for some time, and where large quantities of foreign hides are handled. Damage of the nature mentioned was common in foreign dry hides, but our correspondents had never known of domestic tanned leather being attacked in this manner before.

All of the material received from the New Jersey and Maryland correspondents from silkworm cocoons and leather, respectively, was referred to Mr. E. A. Schwarz, who pronounced the species *Dermestes cadaverinus* Fab. This species is comparatively rare in the United States, as Dr. Jayne's note on its distribution "merely occurs in Florida" would indicate; but it is one of the many species which affect stored material, and which are thus destined in time to become cosmopolitan.

REMEDIES.

The best remedy for these insects, when they occur in leather and similar substances, is undoubtedly the bisulphid of carbon, and this should be freely used where the insects are most abundant. Where it is possible to remove leather to tight rooms, it can be disinfected in the usual manner; but where this cannot be conveniently done it is more advisable to disinfect entire rooms in the storehouse infested. Silk and cocoons can be even more readily reached by the use of bisulphid of carbon, and this applies to the fumigation of entire rooms; but the hydrocyanic-acid gas treatment can also be employed. This latter is useful where insurance companies object to the use of bisulphid of carbon on account of its inflammability. Directions for the use of bisulphid of carbon are given in Farmers' Bulletin 145, and for fumigation with hydrocyanic-acid gas in Circular 46 (second series), both of which publications can be obtained by application to this office.—F. H. C.

SOME BLISTER BEETLES INJURIOUS TO FRUIT TREES.

For many years past blister beetles of three or four species have been reported at intervals as doing more or less destruction to the foliage of various fruit trees in different portions of our country. The insects in question are quite different from the common species of blister beetles found in potato patches and in fields and gardens generally. They are strictly arboreal, while the latter are terrestrial. Some accounts of recent injury may be of interest, together with the accompanying illustration of one of our best-known forms. All of these insects are handsome creatures of graceful form, and in color different shades of green or olive with yellow or yellow and black legs.

SAY'S BLISTER BEETLE (*Pomphopœa sayi* Lec., fig. 6).—April 29, 1901, Mr. R. J. Black, Bremen, Ohio, sent specimens, as did the other correspondents who will presently be mentioned in connection with this and other species, stating that the beetles were found in great numbers devouring blossoms of Japan plum. The species had not been noticed in previous years, and other varieties of plum, cherry, and peach were not affected. May 13 Mr. C. W. Nash, Toronto, Canada, also reported this species on plum doing great damage to the blossoms.

The **PEAR-TREE BLISTER BEETLE** (*Pomphopœa penca* Say).—May 1, 1901, Mr. Joseph Hampson, jr., reported this species to be destroying the petals, stamens, and pistils of pear blossoms at Pen Mar, Pa. An invasion of this species on pear was recorded as occurring in central eastern Ohio in 1894 (Ins. Life, Vol. VII, p. 204). In 1898 and 1899 it was reported to be destroying the blossoms of young plum at Wooster, Ohio, and Tazewell, Tenn.

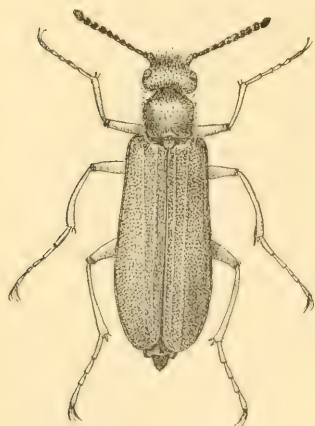


FIG. 6.—*Pomphopœa sayi*: beetle—2½ times natural size (original).

The **TEXAS PLUM BLISTER BEETLE** (*Pomphopœa texana* Lec.).—March 18, 1902, Mr. David Hunter, San Antonio, Tex., wrote of the occurrence of this blister beetle on plum in that vicinity. Six years earlier our correspondent had noticed this beetle feeding on Chickasaw plum in Blanco County of the same State.

The **PEACH BLISTER BEETLE** (*Pomphopœa unguicularis* Lec.).—April 8, 1902, Mr. Franklin Sherman, jr., wrote of the occurrence of this blister beetle at Blowing Rock, N. C., on wild mountain laurel, devouring both blossoms and leaves. It occurred there literally by thousands, attacking also peach trees, eating those which had previously been attacked by leaf curl. The beetles also affected cultivated roses to such an extent that one owner had to resort to spraying to save them. In Volume VI of Insect Life (p. 36) we recorded the occurrence of this species in immense numbers at Whitesides, N. C., where they denuded the locust, *Robinia viscosa*, of foliage. This was at an elevation of 5,000 feet above sea level, and occurred in 1893.

Remedies.—All of these blister beetles undoubtedly feed, in nature, on the blossoms of wild fruits, such as plum, mountain laurel, and the like. On low trees it is not difficult to control them by hand-picking. On higher trees they can be destroyed by means of a spray of Paris green applied in the usual manner. On peach, however, arsenate of lead is best, owing to the danger of scorching the tender foliage of

that tree. Another manner of holding them in check is by jarring them upon curculio-catchers, which can be constructed by means of a sheet stretched and held taut on a frame. If this catcher is saturated with kerosene such insects as come in contact with it will die. As to the success of these remedies, Mr. Hunter, writing of the Texas species, states that it was easily destroyed by hand-picking, as the beetles were not readily disturbed, while Mr. Nash, writing of Say's blister beetle, states that arsenicals could not be applied owing to the danger of killing bees.—F. H. C.

NOTES ON VINE-CHAFERS.

Recent years have witnessed considerable injury locally and, as usual, periodically to grapevine and the foliage and blossoms of various fruit trees by some species of beetles of the genus *Anomala*. Of the dozen described forms of this genus, four are known to affect the grape; hence the name of vine-chaffer, which is rather commonly bestowed on them.

Anomala undulata Mels.—This, one of the commonest species, has been reported during the last two years at Gadsden, Ala., and Tazewell, Tenn. In the first locality the beetles were first noticed by Mr. C. W. Ewing, April 10 at sunset, flying in great numbers from a valley below and settling on peach trees, where they ate both blossoms and leaves. In the latter locality, Mr. H. Y. Hughes observed the beetles destroying buds, bloom, and young fruit of cherry. In earlier years we have recorded the occurrence of this species as injurious to the blossoms of grape, apple, and pear at Grand Bay, Ala., and to grape at Greenville, S. C.

The life history of this species is in some respects like that of the common rose chafer, which is treated in Circular No. 11 of this Division. The beetle, however, is quite different in appearance. It is shown in fig. 7. The color is shining pale yellow, with the thorax mostly black, and the elytra or wing covers spotted with black, much as illustrated, the pattern, however, being quite variable.

Anomala marginata Fab.—This, the margined vine-chaffer has been quite destructive recently at Carterton, Va. Dr. E. K. Harding reports that it occurred in June, 1900, about the middle of the month, and did considerable damage to cherry and Japan walnut, but did not trouble the vine. Many holes were found in the earth under the trees, and when the beetles were shaken off they disappeared into the ground, an occurrence which led our correspondent to infer that eggs might be deposited in the earth from which the larvæ would hatch. This is



FIG. 7.—*Anomala undulata*: beetle—four times natural size (original).

probably true. The beetles, like the rose chafer, were seen in copulation at any hour during the day. Subsequent observations showed that these beetles also occurred in abundance on sycamore and that they even relished the acrid foliage on black walnut.

The beetles also resembled the rose chafer in their sudden appearance, their time of activity (about one month), and their equally sudden disappearance at the end of that time.

Anomala minuta Burm.—The black form of this species was received May 2, 1901, from Mr. B. H. Frazier, Fruitdale, Ala., where it was observed working on young peach and plum trees set out that spring. The beetles burrowed in the ground around the trees to a depth of 1 to 3 inches into the moist earth. They ate only the young, tender leaves. It was also noticed that they seemed to be most numerous in the drier and sandier soil of that vicinity, which suggests that the larvæ probably fed on grasses grown in such locations.

While writing of the habits of these vine chafers it may be well to add that on one occasion *A. undulata* was observed affecting growing wheat, in another case attacking petunias, and in still another affecting grape. *A. marginata* is most commonly found on the vine, as is also *minuta*. *A. lucicola* is also a grape-feeding species, and *binotata* has been found on the grape as well as on strawberry and locust.

Remedies.—In the treatment of these vine chafers we have practically the same problem, in many cases, as in dealing with the rose chafer. The beetles frequently occur in such numbers and devour the leaves of young and tender fruit trees so rapidly that Paris green does not produce the desired effects. In ordinary cases, however, an arsenical spray is sufficient for their destruction. Dr. Harding has met with good success both with spraying and with shaking the beetles off and burning them, in much the same manner as described in connection with the blister beetles which affect fruit trees.—F. H. C.

THE COLORADO POTATO BEETLE IN THE SOUTH.

We have recently received information from many correspondents in Southern localities furnishing evidence that the Colorado potato beetle (*Doryphora 10-lineata* Say) has been making a general effort to extend its range southward. Such migration has been noticed for a number of years past, but has never been so noticeable as during the season of 1901. The species will doubtless continue to spread southward until it is overcome by natural enemies or perhaps killed out by the weather. It has been noticed that this species has been destroyed in great numbers during severe dry spells, such as was experienced during the summer of 1900, the larvæ being literally dried up on their food plants.

Our first information in regard to recent spread by this species was from Mr. N. L. Willet, of Augusta, Ga. For the first time in his remembrance, that section was being devastated. He wrote, May 12,

1900, that within a radius of about 100 miles the country was being devastated, his drug firm receiving daily orders from railroads radiating from the city for Paris green, more of this insecticide being sold in the previous week than in the preceding four years. The opinion was expressed that in future the inhabitants of that region might have to count upon this beetle as one of the expected annual arrivals in spring. The country round about appeared to be alive with them.

May 14, 1901, Maj. Harry Hammond wrote of this species and its destruction of potatoes in the vicinity of Beech Island, S. C. May 24 Mr. John Commer, Ripley, Tenn., wrote of injury in Lauderdale County. The insects were first noticed about the middle of May, and by the end of the month early potatoes were entirely stripped of their leaves. A similar report of injury was received from Mr. Albert E. Seddon, Atlanta, Ga., May 25.

Mr. J. P. Rudolph, Pleasant Hill, Ala., wrote May 27 that the Colorado potato beetle made its first appearance in that locality that year, but the timely application of Paris green checked its ravages.

June 4 we received a communication from Mr. J. C. Russell, Clarks-ville, Tex., in regard to the occurrence of the insect in that vicinity.

It should be remarked that Mr. H. E. Weed, when entomologist of the Mississippi Agricultural College Experiment Station, writing of this species in 1897, published a map showing that in 1896 it had occupied the northern two-thirds of Mississippi, the prediction being made at that time that owing to the large increase in the acreage devoted to Irish potato in that State and throughout the South it was probable that the insect would continue its southward spread to the Gulf of Mexico (Bul. 41, Miss. Agr. Exp. Sta., Mar., 1897, pp. 186, 187).

THE RICE WEEVIL AN IMPORTANT FACTOR IN THE FAILURE OF GERMINATION OF CORN IN THE SOUTH.

In the course of investigations conducted by Mr. E. A. Schwarz, of this office, in Texas, to place the hibernation of the Mexican cotton-boll weevil, it was ascertained that not only the boll weevil but the rice weevil (*Calandra oryza* Linn.) or so-called corn weevil, as it is better known in that portion of the South, made use of cornstalks for winter quarters. Only a few of the boll weevil were observed in comparison to thousands of the rice weevil that habitually hibernate in this manner. The latter beetle also sometimes passes the winter in cotton bolls and in other plants, but cornstalks, owing to the greater degree of moisture which they contain in the pith, form a favorite winter home of this insect. Thus it happens that the careless farmer has to contend not only with the weevils that are present in his corn when planted, but with others which come out of the cornstalks on the approach of warm weather and undoubtedly dig down into the soil to the kernels.

Frequent complaint has been made of the failure of corn to grow in the South, and this explains the reason to a very considerable extent. Most of Mr. Schwarz's observations were made in the vicinity of Victoria, and he related having seen long, uninterrupted rows of these beetles on fences when warm weather tempted them from their places of concealment. Mr. Schwarz brought with him specimens of corn seed that had been planted showing the holes made by the ravages of this insect, which ate out the germ, leaving the remainder practically intact. The farmers usually attributed this failure of germination to crows and other birds, and the truth has never been ascertained hitherto.

The necessity of selecting good seed for planting has been pointed out in Farmers' Bulletin

45, on insects affecting stored grains, as well as in a pamphlet entitled "Insects Injurious to Beans and Peas." It is now in order to advise cleaner culture, consisting of the destruction of cornstalks before the insects which have hibernated in them issue. This is a measure of the greatest value not only in controlling the rice weevil, but many other granary insects which lead a more or less outdoor existence in the South, such as the grain beetles, *Silvanus* and *Cathartus*, the

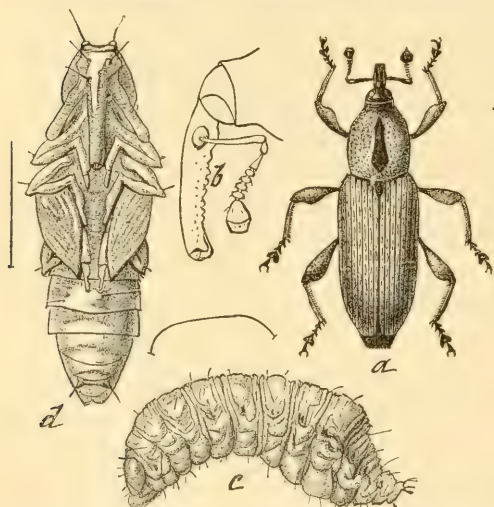


FIG. 8.—*Sphenophorus obscurus*: a, adult, enlarged; b, head of adult, from side, still more enlarged; c, full-grown larva, from side; d, pupa, ventral view, both enlarged (from *Insect Life*).

flour beetles, *Tribolium*, etc., and some other species.

THE SANDWICH ISLANDS SUGAR-CANE BORER AGAIN.

It may be remembered by our older correspondents that we published in Volume I of *Insect Life*, on pages 185-189, an illustrated account of *Sphenophorus obscurus* Boisd., a species which we may call the Sandwich Islands sugar-cane borer. We have several times received this species from different sources, and some articles and shorter notes have been published in regard to it, most of which are referred to in the article cited. February 18, 1902, Mr. Jared G. Smith, special agent of this Department in charge of the Hawaii Experimental Station at Honolulu, Hawaiian Islands, wrote us from Spreckelsville, Maui, in regard to severe injuries by this insect. As some of our

present readers may not have access to the volume of *Insect Life* to which we have referred, the illustrations there presented are reproduced (figs. 8 and 9). Mr. Smith writes substantially as follows:

I am sending you herewith specimens of the cane-borer which infests the sugar-cane plant throughout the rainy districts of Hawaii. It is quite rare in the dry districts or in dry years, but is terribly destructive in wet years or on plantations in regions with abundant rainfall. On one plantation on Maui the loss last year from the cane-borer was estimated at between 1,000 and 1,500 tons of sugar—20 per cent of the crop. At an average price for sugar of \$70 per ton it is not difficult to figure up a pretty stiff bill against the cane-borer.

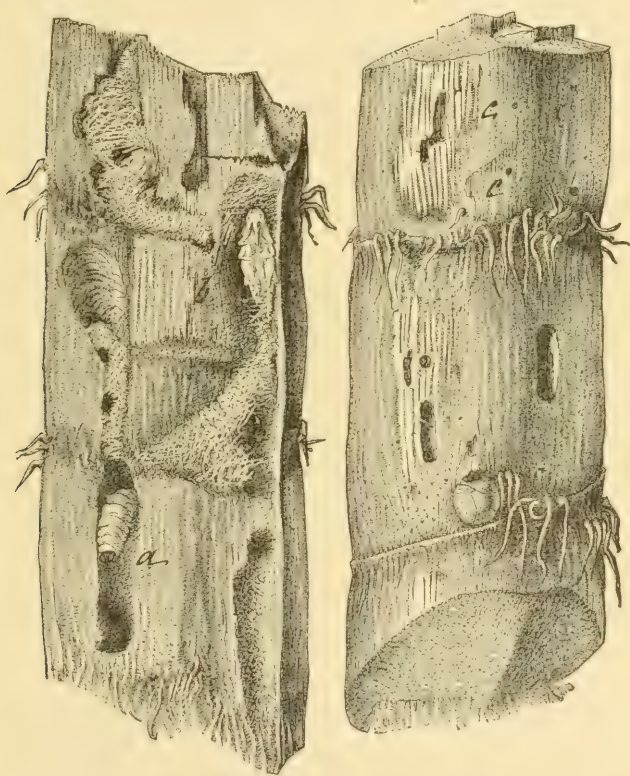


FIG. 9.—Sections of sugar cane showing work of *Sphenophorus obscurus*: a, larva; b, pupa, in situ; c, probably points of oviposition—somewhat reduced (from *Insect Life*).

From its habits I judge there is no hope of trapping, poisoning, or otherwise destroying it, and it looks as though we would have to find a natural enemy for it. The toad has been tried, but the mongoose is too fond of toad for breakfast.

The eggs are apparently laid in the sheath of the old leaves of the cane a little above its junction with the node. The egg hatches out in the sheath and the young grub eats its way into the cane just above the node. The hole where it enters is very small and hardly visible. Once inside the grub grows rapidly and channels back and forth, rapidly converting the lower internodes into a mass of feces. The grub pupates in the cane and only emerges from the stalk as a beetle to copulate, and do it all over again. Several of those which I send were caught in the act. The

imagos are found inside the sheaths of the dead leaves on the lower part of the stalk during the daytime, and apparently only fly at night.

Not being an entomologist, I don't know what other information would be of value to you. The grub is found only in the mature basal joints of the cane stalk—the portion of the stalk which is richest in sugar. I do not think that the imago is attracted by light; anyway it would be dangerous to have a light in a cane field on account of the danger of fire.

Ten tons of cane per acre are sometimes destroyed by the borer.

Since writing the above I have talked with Mr. A. Koebele. He says the borer is probably a native of Tahiti, or at least that it was introduced here from there, but that it also occurs in Samoa, Fiji, New Guinea, and other southern Pacific island groups. Also that it infests the banana, wine palm (*Caryota urens*) and other palms, the papaya (*Carica papaya*), and a good many other tropical crops.

Hon. H. P. Baldwin, who gave me most of the preceding information, says that the cane borer is the worst insect pest in Hawaii, and that a conservative estimate of the amount of damage done by it would be at least \$500,000 per annum.

UMBRELLA ANTS IN CUBA.

During the first week of June we received two communications in regard to an ant native to Cuba and designated by the natives as "bibijagua." Mr. Thomas R. Towns, Quiebra Hacha, province of Pinar del Rio, wrote May 27 that this insect, which is probably *Atta insularis* or a related species, is as industrious as any animal alive, working as late as 12 o'clock at night, when the dew puts a stop to its work. At 10 next day it is out again. The ants stripped a nursery of every leaf of orange, showing a preference for the tender leaves. They are described as taking a row of young stock about an eighth of a mile long, tree by tree, never missing one nor leaving a leaf. When this row is finished they take the next. Our correspondent stated that he "ran them out" by tarring a rope with pine tar and laying this around the plot attacked.

Mr. E. T. Fries, Santa Fé, Isle of Pines, complained of the same species and its injury to orange. He had noticed its habit of living in colonies in immense hills of earth, with galleries, chambers and tunnels, and with well-beaten paths in many directions leading to the hill. Along these the ants traveled, each carrying a bit of leaf often several times as large as the ant itself. The ants are officered by one of larger size.

THE GAGE BUG.

During the time that this Division issued the periodical publication, Insect Life, which reached an edition of seven volumes and has now been discontinued, we had frequent occasion to mention the popular names of our common insects. Such notes as we published frequently elicited interesting correspondence.

January 30, 1902, Mr. James Riley, of New Dorchester, Mass., wrote in regard to popular names, giving an account of the "Gage

bug," which we reproduce below in its entirety. There is little doubt, from the description of the insect, as chunky and not flying, that he has reference to the common squash bug, a well-known enemy of pumpkin and squash vines. It is probable that General Gage did not have a very extensive knowledge of entomology, and judged this insect to be more destructive than it really was, owing to its somewhat disgusting appearance and still more displeasing odor. The following is in reference to one of the Entomologist's lectures delivered at the Lowell Institute during the month of January:

In common with all your auditors I have been pleased and instructed with your heart and head talks on insect life. I was waiting all the time to hear of one of my old enemies, the Gage bugs. You may have mentioned them in your second lecture, which I missed. They may have been the Hessian fly, but if my memory serves they came with them, but were more chunky, and did not fly. I was reminded of them when in your first lecture you said that people often named pests after what they disliked, as the French weed in English-speaking Canada and the Abe Lincoln bug in Georgia. So too with the Gage bug. The old man who brought me up was an Alden but five generations from the historic John. He used to tell me in hoeing time (in the late 50's and early 60's of the century that was) that General Gage after the battle of Bunker Hill, finding he could not "whip us," went up on the hill the next day and, opening his snuff box, let out the bugs that we were then killing on our pumpkin and squash vines. He would describe most lucidly the battle before telling the story, and so I never stooped to "squash" a Gage bug in those days without seeing a general in red on a high hill, snuff box in hand, out of which issued a living line of pestilence as the bugs swarmed in perspective down the thirteen colonies. Such was a lesson in natural and political history of an old-time Yankee to an Irish boy forty years ago.

THE PROBABILITY OF THE OCCURRENCE OF THE MEXICAN COTTON-BOLL WEEVIL IN BRAZIL.

We have received information leading toward the conclusion that the cotton-boll weevil (*Anthonomus grandis* Boh.), or an insect of very similar habits, has been present for some years in the cotton regions of Brazil, notably in the State of Bahia. Professor d'Utra, director of the State agricultural station of São Paulo, has written a rather extensive article upon this subject, in which he considers that there is no doubt that the insect is *Anthonomus grandis* (Boletim de Agricultura, 2d ser., No. 4, pp. 211-229, 1901). In our efforts to obtain specimens we have been favored by Prof. Adolph Hempel, of the same station, with the information that, although there may be some uncertainty about the identification, the fact remains that in the State of Bahia there occurs a small beetle that lives in the cotton bolls, especially within the seeds. This describes exactly the method of work of the boll weevil in southern Mexico and Central America, as noted by Townsend, though in Texas it never occurs within the seeds.

In the absence of specimens only speculations regarding this matter are to be indulged in. There is, however, an authentic record of

the occurrence of this insect in Cuba in 1871. Nevertheless, it is practically certain that in 1882, at the time of the visit of Branner and Koebele to Brazil, *Anthonomus grandis* did not exist as an enemy of cotton in the State of Bahia or elsewhere in that country. Moreover, none of the principal works dealing with the Coleoptera of that portion of South America mentions the species. Although this by no means demonstrates that *Anthonomus grandis* may not now be found there, it certainly tends to indicate that if the species has made its way into Brazil, it has, in less than twenty years, increased its range remarkably.—W. D. H.

THE ST. ANDREW'S COTTON STAINER.

Mr. J. J. de Barril, the proprietor of a cotton plantation in the interior of Cuba, has given us interesting details concerning *Dysdercus andrew* L. This species, like *D. suturellus* H.-S. of the southeastern United States, is a cotton stainer. It sometimes occurs in such numbers that if cotton culture is again engaged in extensively in the West Indies it may become considerably more important there than its congener in this country, which has for many years ranked as a pest of only secondary importance.

Some years ago this insect was the subject of one of Prof. T. D. A. Cockerell's stylographic notes (Institute of Jamaica, Notes from the Museum, No. 9, Feb. 24, 1892). The common name we have used was suggested by Professor Cockerell, and is in allusion to the white cross formed by the markings on the hemelytra which Linnaeus also referred to in the Latin name he gave the species. In the adults this coloration is quite striking. More than a century ago Sloane, a traveler in Jamaica, referred to the insect as "a Cîmex of a scarlet colour with a white St. Andrew's cross on its back. This is one-third of an inch in length. It is very often to be met with amongst flowers."

Our correspondent states that on his plantation, where until last year no cotton had been planted for nearly half a century, the cotton bolls were frequently so covered that nothing but a mass of red and black insects was visible. This happened in January and February, before the fruit opened, and no effect upon the plant, except that of dwarfing the bolls, was observed. Toward the end of March, however, when all of the bolls had burst open and most of the staple had been gathered, the pests fell upon what remained, and then the staining of the fiber became most noticeable. The color of the stain was yellowish brown or ferruginous. Another observation suggests a probable effective method of destroying the pests. All the hollows of stumps or trees in the cotton fields were noticed to be filled by millions of the immature insects. These did not eat the leaves of the cotton plant, but were found crawling over the grass and tobacco

plants which were planted in the vicinity of the cotton. In these situations it would be an easy matter to destroy the pests by means of hot water, or kerosene emulsion, or a mechanical mixture of kerosene and water.

The species is generally distributed in the West Indies. It has been reported from San Domingo, Jamaica, and St. John, and Mr. O. Heidemann's collection contains specimens from Cuba and Montserrat. It did not appear, however, in the extensive Smith collection of Hemiptera from Granada, W. I., and likewise seems to be unknown in Mexico and Central America.—W. D. H.

STOPPAGE OF ELECTRIC LIGHTS BY INSECTS.

The Electrical World and Engineer of August 9, 1901, says that recently at St. Paul, Minn., the electric lights were stopped by an accumulation of shad flies, 18 inches from wire to wire, shutting off the current of 25,000 volts. The shut down by a short circuit between the wires lasted an hour, and it was found necessary to station an attendant to remove the constantly accumulating insects with a hoe. The figure illustrating the article represented a Bibio, but the text says that the creatures were shad flies.

A VARIETY OF WHEAT SAID TO BE IMMUNE FROM HESSIAN FLY.

Maj. William R. King, ex-chief of the seed division, Department of Agriculture, returning from Buffalo, and having interviewed several New York wheat growers, reports that he is authoritatively informed that the only variety of wheat which practically escaped the great damage which the Hessian fly did in that part of the State during the season of 1901 is Dawson's Golden Chaff. The peculiarity in the wheat is that the straw is very stiff and tillers abundantly. It originated at Guelph, Ontario, Canada, at the Dominion Experimental Farms. It has been extensively planted in Canada, also in western Michigan, not only at the Agricultural College, but in the vicinity of Grand Rapids.

A WESTERN CRICKET IN OREGON.

July 30, 1901, Mr. R. J. Hollis sent specimens of one of the so-called western crickets (*Anabrus purpurascens* Uhl.) from Andrews, Harney County, Oreg. Our correspondent had never seen this species in California or elsewhere, but knew that it was a yearly visitor in the vicinity from which he wrote, staying about six weeks, after which it either died or disappeared in some unexplained manner. It was noticed that it was migratory. In some places there were millions of them, and they ate everything from garden truck to leather and canvas, and even each other. They appeared to be sensitive to heat and cold, and were described as herding together like hogs during the

night, while in the hottest part of the day they got under cover out of the sun. It was an interesting sight to see so many of them jumping and hopping like frogs. They were so large and ravenous that it took much vegetation to appease their appetites. They soon cleaned out a garden. The species appears to be peculiar to arid regions.

NOTES FROM CORRESPONDENCE.

Tobacco for mushroom fumigation.—John T. Cochran, Claymont, Del., writes that tobacco fumigation has been practiced with some success for mushrooms. It did not entirely remove the insects, but killed many of them. Our correspondent believes that a mild fumigation with tobacco stems, as suggested by us, at frequent intervals before the crop begins to show, will keep down insect pests.

Insect injury in Texas.—Mr. John Nagle, a Texas correspondent, of Gainesville, Cook County, writes under date of July 4, 1902, that every year the State loses 25 per cent of all crops through insect depredations, not including losses from other causes, the latter modifying clause being added because the year 1902 at that time gave promise of being one of great deprivation, as many farmers would suffer for the bare necessities of life in that portion of the State at least, where people were going 10 miles for water for use on their farms.

The apple twig-borer (*Amphicerus bicaudatus* Say) **injuring honey locust.**—This species, which is also called grape cane-borer and which is known to attack a variety of fruit, forest, and shade trees as well as shrubs, was received May 24, 1902, from Mr. W. S. Robb, Lacrosse, Kans., who reported that it was feeding on honey locust. As in the case of attack to apple, the beetles perforate the bark near a bud, thorn, or branch, generally above, and work directly toward the heart.

The pear-blight beetle in the Pacific region.—May 23, 1902, Mr. Harry G. Smith, Vancouver, Wash., sent twigs of Italian prune injured by this species, known also as the shot-hole borer (*Xyleborus dispar* Fab.), with the information that considerable injury was done in that region. Mr. Smith stated that the proportion of trees killed in his young orchard was about 10 to 75. June 12 we received a package of specimens from Ely, Oreg., containing beetles and a score or so of bits of twigs showing injury by this insect. These are the first instances of injury, to our knowledge, that have been recorded for this species in the far West. It would be interesting to learn how general the attack is, and whether the insects were introduced from our Eastern States, where the species has been present for half a century or more, or from Asia, where it occurs in Siberia.

Peculiar larval habits of a leaf-beetle affecting prickly ash.—During 1901 and 1902 Mr. J. D. Mitchell, Victoria, Tex., sent specimens of *Trirhabda brevicollis*, stating under date of May 4 of the former year that the larvæ burrow into the ground where it is slightly raised, making runs or galleries, from which they crawl out and about day and night, but never more than a few inches from the colony home. The following year he reported that he had found a large colony tunneling into a small hillock and crawling around on the surface of the ground, and had observed also that the pupal stage was passed in the ground, the mature insects issuing about ten days from the time that the larvæ disappeared. May 7, 1902, he noted that a large colony of the beetles, which are not unlike the common elm leaf-beetle (*Galerucella luteola*) in appearance, had about ten days later completely defoliated a large prickly ash (*Xanthoxylum americanum*). As with other species of this genus, the beetles are very sluggish, seldom flying, but dropping to the ground when touched or disturbed, and crawling slowly. Mr. E. A. Schwarz, of this office, has observed the same species at Victoria, Tex., often entirely defoliating the brush-like trees of this worthless plant. What is considered to be the same species occurs in Michigan and all over the Eastern States wherever this plant occurs.

Blister beetles attracted to lights.—Mr. Otto Holstein, Cline, Tex., wrote during August, 1901, that he succeeded in getting rid of blister beetles as well as other insects by placing a lighted lamp in a basin of water; the insects flying about the light invariably fell into the water and drowned, a little oil upon the surface rendering it impossible for them to escape. This is an old-time remedy against a number of insects, and it is well known that blister beetles are frequently attracted to lights in considerable numbers. The trouble with this remedy, however, is that it is apt to destroy also many beneficial insects.

Parasites of the tent caterpillar (*Clisiocampa americana* Harr.).—Writing June 17, 1902, Mr. F. E. Brooks, Frenchcreek, W. Va., sent specimens of parasites of this species, with report that out of 43 cocoons collected on apple trees 9 yielded moths and 8 the tachina fly (*Frontina frenchii* Will.), while all the remainder gave 201 individuals of the ichneumon (*Pimpla maura* Cr.). Later, our correspondent sent two chalcids fly parasites (*Miotropis clisiocampæ* Ashm. and *Dibrachys boucheanus* Ratz.), as well as a species of Comoplegine from the same host.

Parasites of the plum curculio.—Mr. Brooks also sends us from the same locality a Braconid parasite of the plum curculio (*Conotrachelus nenuphar*), viz: *Bracon mel-litor* Say; and a chalcid fly, a species of *Eurytoma*, also a parasite of the curculio.

Note on Pogonomyrmex barbatus, one of the agricultural ants of Texas.—Mr. G. M. Dodge has recently sent specimens of this ant, together with samples of seeds on which he observed it feeding at Ingram, Kerr County, Tex. These seeds have been identified by Mr. A. J. Pieters, of the Bureau of Plant Industry of this Department, as Texan grama (*Bouteloua texana*), sand bur (*Cenchrus tribuloides*), and lance-leaved sage (*Salvia lanceolata*). Our correspondent stated that he had seen the ants harvesting these seeds.

A Cimbex in British Burma.—Mr. George Field, of Washington, an importer of orchids, found attached to the roots of *Dendrobium wardianum*, an orchid from British Burma, a rough, brown silken cocoon from which issued May 17, 1902, in the insectary of this Department, a new species of sawfly of the genus *Cimbex*. This fact is of very considerable interest, since it seems that no species of this genus has ever been taken in Farther India.

Note on the ox warble in Mississippi.—March 27, 1902, Mr. Lawrence C. Johnson, geologist, Pachuta, Miss., wrote in regard to this species, which is also called the ox bot or heel fly (*Hypoderma lineata* Vill.), stating that about two weeks prior to the date of writing, with the first spring-like weather, this species had appeared in large numbers and had proved a great torment to cattle. The insect did not confine itself to attack on the heel, this, according to popular belief, being because the cattle stamped so much.

Christian Science for Cattle.—Mr. Franklin, formerly district attorney at San Antonio, Tex., vouches for the fact that two cattle owners at Llano, Tex., treat their cows for screw worms by Christian Science.

Scavenger flies as a creamery pest.—A correspondent at Garrison, Mo., writing May 16, 1902, transmitted specimens of the fly *Calliphora rividescens* Desv., with the report that these insects were new, and that they were troublesome in a room where milk was kept. They laid eggs in the cream when it was nearly sweet and beginning to turn. They did not appear to infest the butter, but tried to get into the sweet milk.

Notes on kissing bugs.—June 28, 1902, we received a specimen of *Reduvius personatus* Linn., from Mr. W. T. Hubbell, Philo, Ohio, with the information that it was caught in the night within the folds of a lady's nightdress after twice stinging her. The lady described the sensation as like the sting of a wasp, causing sickness and something like a chill, symptoms which, however, might have been due to nervousness, as the lady was not very strong.

July 28, 1902, Mr. J. C. M. Johnston, New Wilmington, Pa., sent a minute larva of a lace-winged fly (*Chrysopa* sp.), with report that it had bitten him on the hand,

and the sensation which followed was similar to that due to the bite of a mosquito, but no inflammation took place.

Tobacco as a remedy for grape leaf-hoppers.—Mr. Fred W. Card, Kingston, R. I., writes October 19, 1901, that a Mr. Saunders found tobacco stems on the floor of his grapery an effective remedy against grape "thrips" or leaf-hoppers (*Typhlocyba*). Mr. Card also suggested that after thoroughly clearing out the leaves and refuse during the fall the vines and houses should be thoroughly sprayed with kerosene emulsion.

The use of harvest spiders in medicine.—A correspondent from South Carolina sends us specimens of *Liobutium formosum* Wood, with the legs removed and the bodies packed carefully in gelatine capsules, with the remark that he has found them a sure cure for malarial fevers.

Negro superstition in regard to stinging ants.—The negroes of Louisiana have a superstition, an animistic belief in the little ant (which we call the bulldog ant (*Mutillid*) for the reason that it is always running around hunting other insects) that if they cook this in a piece of corn bread or mush and feed it to a young pup that it will make a good hunting dog out of the pup. As a general thing, this has to be done by some old hoodoo doctor. I went to work and did the thing myself, and the results were not satisfactory. So I told him it didn't pan out, and he said: "Well, that is because you didn't send for me. Give him to me, and I'll fix that dog up."—*E. S. Hallock, Washington, D. C.*

Successful infection of a wireworm with *Cordyceps* fungus.—July 6, 1902, Mr. C. W. Nash, Toronto, Canada, wrote that he had been successful in infecting the larva of an Elaterid beetle with a fungus disease, a species of *Cordyceps*. Somewhat prior to the date of writing, larvæ were noticed affected by this disease, and the spores were confined with other larvæ received from a distance, with the result that several of these larvæ were taken with the disease. Writing later, July 21, our correspondent sent a specimen of infected wireworm which Mr. E. A. Schwarz has identified as a species of *Drasterius*, and with little doubt *dorsalis*. This specimen had the fungus growing from the side of the head. The fungus was described as growing straight up until it reached the top of the jar in which it was confined. The specimen sent measured between 4 and 4½ inches.

Cutworm injury to ginseng.—Mr. George Adams, Detroit, Mich., writes in regard to injury done by cutworms to 2,000 valuable ginseng plants (*Aralia quinquefolium*). He states that they were all gnawed off at night, and that the plants were vigorous and healthy until cut down. In Pulaski County, Mich., he states that ginseng seed is selling at from \$5 an ounce to \$120 a pound, and that he had lost his entire crop of seed for the year.

The unicorn worm in a new role.—Under date of July 29, 1902, Mr. C. P. Crowell, Rochester, N. Y., sent a specimen of the larvæ of *Schizura unicornis* S. & A., with report that it was devouring the leaves of plum in that vicinity, literally eating everything as it went, leaves and plant-lice included. This insect, as is well known, is a rather general feeder on deciduous woody plants, but its habit of feeding on Aphides has not been recorded to our knowledge.

U. S. DEPARTMENT OF AGRICULTURE.

DIVISION OF ENTOMOLOGY—BULLETIN NO. 39, NEW SERIES.

L. O. HOWARD, Entomologist.

THE CULTURE

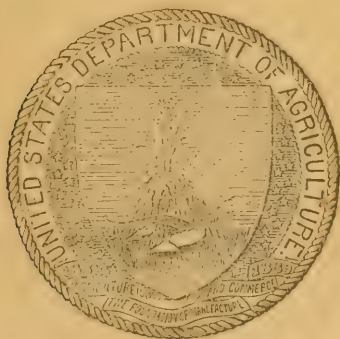
OF

THE MULBERRY SILKWORM.

BY

HENRIETTA AIKEN KELLY,

SPECIAL AGENT IN SILK INVESTIGATIONS.



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WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1903.

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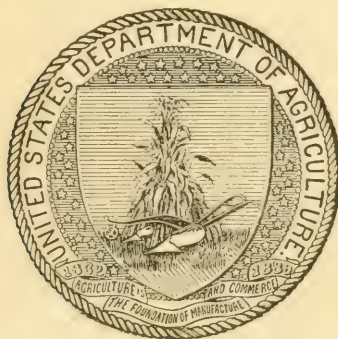
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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
DIVISION OF ENTOMOLOGY,
Washington, D. C., January 31, 1903.

SIR: I have the honor to transmit the manuscript of a bulletin which has been prepared under my direction by Miss Henrietta Aiken Kelly, a special agent of this Division, and which treats of the culture of the mulberry silkworm in a plain yet complete way. It is intended to distribute it among persons who wish to begin the culture of the mulberry silkworm in different parts of the United States. I recommend that this manuscript be published as Bulletin No. 39, new series, of this Division.

Respectfully,

L. O. HOWARD,
Entomologist.

HON. JAMES WILSON,
Secretary of Agriculture.

PREFACE.

To inaugurate the public instruction in silk culture on a modern scientific basis this bulletin, the first of a series, is prepared.

The information given was gained at original sources, during a long residence in Italy and France, and by practical experience under skillful sericulturists. Many Italian and French authorities have been cited, and special acknowledgment is due to Dr. A. Hugues for permission to quote from his "Practical instructions," recently published in *L'Intermédiaire des Bombyculteurs et Entomologistes*, Ardèche, France.

HENRIETTA AIKEN KELLY.

CHARLESTON, S. C., *January 15, 1903.*

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THE CULTURE OF THE MULBERRY SILKWORM.

The caterpillars of many moths and of a few butterflies produce silk, but certain of those belonging to the family Bombycidae, or true silk-spinners, particularly *Bombyx* (*Scricaria*) *mori*, or the mulberry silkworm, yield the most and the best silk. The races of *Bombyx mori* to-day are the result of domestication and artificial rearing, and the wild type is uncertain, though most authorities assign the foot of the Himalaya as the cradle of the mulberry silkworm. It has been industrially cultivated in China from time immemorial, and in Europe since the sixth century.

THE LIFE OF THE SILKWORM.

Like all insects of its class, before arriving at the perfect winged state, it exists (1) as a caterpillar or larva, and (2) in a chrysalid state.

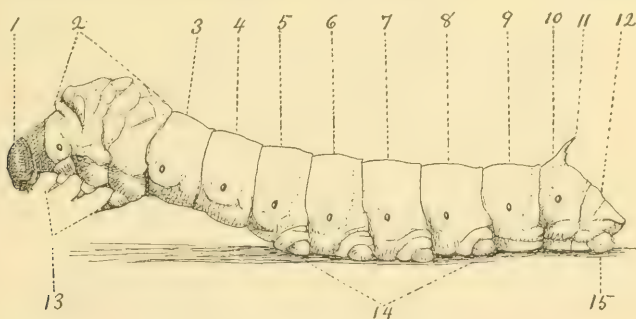


FIG. 1.—Adult silkworm: 1, head; 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, rings; 11, horn; 13, 3 pairs of articulated legs; 14, 4 pairs of abdominal or false legs; 15, a pair of false legs on the last ring.

THE LARVA, OR CATERPILLAR.

The larva (fig. 1) has a cylindrical body composed of 12 rings; each of the first three rings has a pair of jointed legs, and the sixth, seventh, eighth, ninth, and twelfth each bears a pair of false legs, destined later to disappear.

The black elliptical spots on the side are the orifices for breathing, and are called stigmata or spiracles.

The head is a small mass covered with a hard scale, and is provided with jaws that move laterally, like the wings of a folding door. The alimentary canal extends throughout the entire length of the body, and on each side of it is placed a silk gland (fig. 2). These consist of two whitish or amber-colored cords, which after innumerable curves unite in the spinneret in the region of the mouth. There are also two glands, whose excretory canal opens in the spinneret, and covers the silk as it comes out with an impermeable varnish rendering it insoluble in acids and alkalies. This varnish is about a fifth of the weight of the thread.

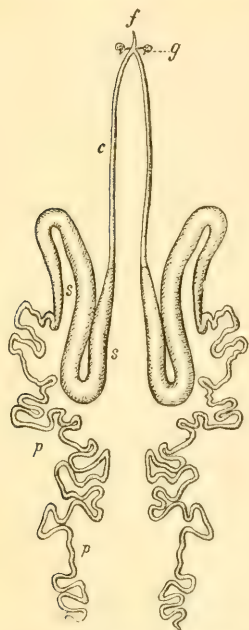


FIG. 2.—Silk glands in a mature worm: *p*, portion of glands which secrete the silky matter; *s*, reservoir; *c*, conducting canal; *f*, spinneret; *g*, accessory glands (redrawn from Verson and Quajjat).

Hatchings usually occur annually in the spring. Simple contact with the air causes the new-born insect immediately to acquire a volume larger than it had in the egg, and it quickly begins to gnaw the under surface and edges of the mulberry leaf. It eats day and night at all hours, except when asleep, and in about thirty days grows 14,000 times larger than it was at birth.

As the silkworm grows larger it becomes paler in color, because its dark chestnut brown hairs are scattered over a larger surface, thus showing more of the true color of the skin.

About five days from its birth the vitality of the larva decreases, and it eats scantily or not at all, and becomes thin and whitish in color. Then it moves around unquietly, and finding a convenient place attaches itself to it, holding on by its false feet. It thus remains motionless, with the front part of its body raised up, for a period of time varying according to temperature, and takes its first so-called "sleep," or molt, during which time the body undergoes extraordinary modifications. The skin is entirely shed, and all the tissues that can not keep

up with the rapid growth of the insect are changed.

The scale which covers the snout is the first part of the case to fall, and a new case appears under the former one. The worm then pushes itself forward through its first ring, sets at liberty the legs of the thorax, and by a wriggling movement comes out of its old sheath.

To aid the insect in this difficult change a liquid is secreted between the old skin and the one forming beneath it, which facilitates the separation.

The life of the larva is usually divided into five ages, varying in

length according to temperature, frequency of feeding, race, and the robustness of the worm. The following is about the average:

First age, from birth to first molt, five to six days.

Second age, from first to second molt, four days.

Third age, from second to third molt, four to five days.

Fourth age, from third to fourth molt, five to seven days.

Fifth age, from fourth molt to maturity, seven to twelve days.

Some time after each molt, perhaps the time needed to regain lost strength and to solidify the newly-formed organs, the worm remains in a state of relative torpor. Not much practice is needed to recognize when it has come out of its "sleep." It moves its head and thorax, which are whitish, while the rest of the body is gray, and has completely lost the shining aspect which it had when the worm began to molt. When fairly through its first molt the larva begins again to eat, and its hunger does not cease until it is ready for a new molt.

Four molts having been made, the worm eats a prodigious quantity of leaf until it reaches its maximum growth, when its appetite diminishes and ceases altogether. It then stops moving and remains for some time in repose, evacuating, meanwhile, its digestive canal, thus losing up to 12 per cent of its weight. Its lean body is now white or yellow, according to the race, and semitransparent.

Very soon it begins to move about again, lifts up its head, which is longer and more pointed, and turns in every direction seeking to find a convenient angle, finding which, it throws out a silk thread from its spinneret. First a net is formed to hold the cocoon which is to be spun, then the regular spinning begins and the form of the cocoon is designed. For some time through the veil which very soon is to surround it, the diligent larva, with its back turned outward, may be seen completing its task. It is calculated that with its head alone the silkworm makes 69 movements every minute, describing arcs of circles, crossed in the form of the figure 8 (fig. 3, *a*).

Meanwhile the web grows closer and the veil thickens, and in about seventy-two hours the worm is completely shut up in its cocoon, which serves it as a protective covering.

THE CHRYSALIS.

In the cocoon the silkworm goes through the last phase of its larval life. After four or five days the skin breaks, and the insect which issues from this old covering is the chrysalis, whose weight is often only half that of the larva at its highest development (fig. 3).

The chrysalis seems to have neither head nor feet, is golden-colored at first, and then turns chestnut brown. The skin dries rapidly and forms a hard case, on which the lines of only the posterior rings are seen, the place of the first three rings being covered with the wing-cases.

The chrysalid state is in certain respects a sleep and in others a period of great activity, in which the entire being is transformed. Wings, antennæ, reproductive organs, and legs are all now developed. This

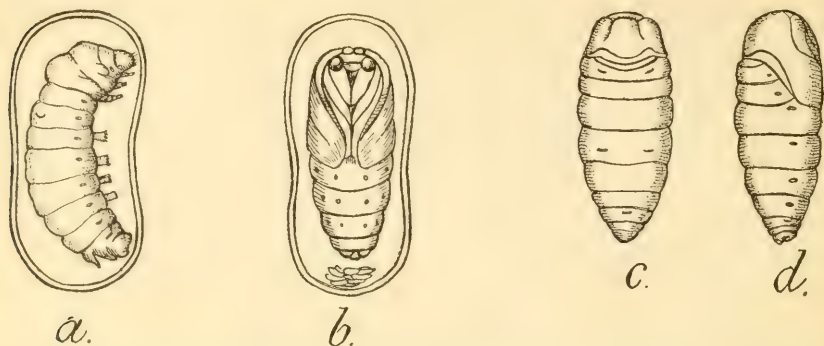


FIG. 3.—The chrysalis: *a*, silkworm completing its cocoon; *b*, cocoon and chrysalis—cast-off skin of larva beneath; *c*, back view of chrysalis; *d*, side view of chrysalis. (Redrawn from Maillot.)

state lasts from eighteen to twenty days, according to the temperature. Then the metamorphosis is complete, and the sheath breaks in the region of the head and out of the old case the moth or perfect insect issues.

THE MOTH.

The larva in spinning the cocoon leaves one end less dense, so that the threads open freely to permit the egress of the moth. By the aid of an alkaline fluid the moth softens and parts the threads and liberates itself.

The moth (fig. 4) comes out of the cocoon, as the larva out of the egg, in the early morning hours. It has a distinct head, thorax, and abdomen, four wings, two comb-shaped antennæ, three pairs of legs, and a pair of compound eyes.

Shortly after emerging, the moth deposits a liquid substance, generally white, sometimes colorless and sometimes reddish, and then the union occurs, lasting several hours, after which the eggs are laid either immediately or in the course of four or five hours.

A gelatinous substance supplied by two glands near the extremity of the oviduct covers the eggs as they come out, and causes them to adhere to the substance on which they are laid.

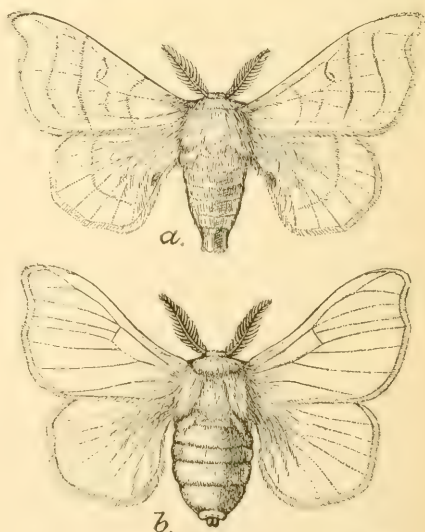


FIG. 4.—The moth: *a*, the male; *b*, the female

The laying, consisting of 300 to 700 eggs, is generally completed in three days, 70 to 80 per cent being deposited the first day, 20 to 30 per cent the second day, and a few the third day. The mother moth dies six to twelve days later, her death being usually preceded by that of the male. Death occurs more or less speedily, according to the robustness of the moth, the temperature, and the tranquillity in which it has been left.

Thus in about sixty-five days the silkworm has completed its cycle of existence, its three periods being thirty to forty days in a larval state, fifteen to twenty days as a chrysalis, and eight to twenty days as a moth or perfect insect.

The rapid development of the silkworm and its marvelous transformations indicate extraordinary power and very active functions. Its respiration is almost equal to that of the frog and of certain large birds, which is equivalent to saying that it must be always surrounded by plenty of pure air.

THE FOOD OF THE SILKWORM.

The leaf of the white mulberry^a is the natural and the best food for the silkworm. There are many varieties of the white mulberry—some much better adapted than others to commercial silk culture, and some better suited to certain localities.

The race, the size of the worms, the variety and age of the mulberry, the nutritive quality of the leaf, the year, the season, and the climate make the requisite quantity of leaf very variable. The following is given as a basis of calculation, all circumstances being considered, and the leaves not being cleaned: For the larvæ hatched from 1 ounce of eggs, during the first age, 11 pounds of leaves; during the second age, 26 to 33 pounds; during the third age, 88 to 145 pounds; during the fourth age, 264 to 352 pounds; during the fifth age, 1,540 to 1,760 pounds; or about 2,200 pounds in all, of which one-half is consumed in the last six or seven days of the fifth age.

The age of the leaf should be relative to that of the worm. Young worms fed on old leaf, or old worms fed on young leaf, are apt to become diseased, and even though they may not die, will scarcely mount or will spin indifferently. A change of leaf, too, should, if possible, be avoided, or made gradually. Fresh leaf only should be used, and never when wet with dew or heated, or before it has in a measure acquired the temperature of the room in which the worms are being reared. It should be gathered early in the morning or in the evening and should not be bruised or torn, nor should the baskets or aprons used to carry it be the same which are used to remove litter. To avoid fermentation the leaves must be spread out in a cellar or cool, dark-

^aFor complete information regarding the mulberry, see Bulletin No. 34, Bureau of Plant Industry, U. S. Department of Agriculture.

ened room. Cut up only a limited quantity of leaf at a time and cover with a damp cloth to keep fresh, but never submerge the leaf in water, as this is apt to occasion *flacherie*, a very destructive disease. From the fourth age on there should always be a day's supply ahead, so that in case of rain the worms will not have to fast.

In gathering leaf, always strip the branches from base to top, so as

not to tear the bark and injure the new buds. It is above all essential to strip the tree entirely of its leaves, for if leaves are left on some branches they will there attract the sap, while the bare branches will be imperfectly nourished. Always strip the young trees first. The sacks for holding the leaves should have a hoop around the opening and a hook to suspend them to the branches.

Restricting the height of the trunk of the mulberry to 5 or 6 feet makes it possible for old women and children to gather leaf, thus diminishing the cost of labor one-half, a most important point in commercial silk culture.

It is also important to cultivate trees that bear little

or no fruit, for the production of fruit not only consumes part of the strength of the tree, but much labor is involved in being compelled to divest the branches of fruit before they can be used as food for silkworms.

The stump mulberry, or that growing low like a shrub, the hedge mulberry, and that which grows along walls vegetate much earlier than the medium and high trunk trees. Silkworm rearers should always have a ready supply of leaf for the first ages of the worm, and especially is this necessary if early cultures are desired with a view to escaping the heated days of May and June.

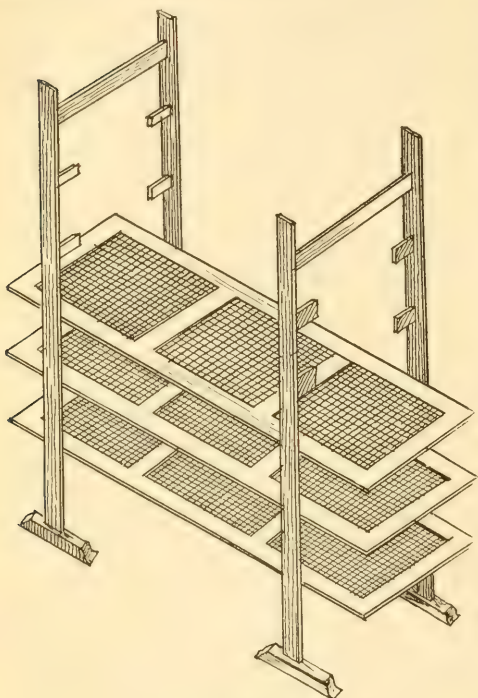


FIG. 5.—Light movable shelves.

IMPLEMENTS NECESSARY TO SILKWORM CULTURE.

Commercial silk culture requires a smaller outlay of capital than almost any other industry. The net gain the first year may pay for an outfit which will last for many years. The following articles are indispensable:

- (1) Some very light movable shelves, permeable to air, for the first ages; and, for the following ages, latticed shelves about 3½ feet wide, and stands to support them.
- (2) Unsized ordinary wrapping paper or newspapers to cover the shelves.
- (3) A small ladder, if necessary, to reach high shelves.
- (4) Small trays to remove worms.
- (5) Knives to cut leaves and baskets to distribute them.
- (6) Coarse tulle and nets or perforated paper for changing beds and equalizing the worms.
- (7) A supply of brush, straw, or shavings to construct the spinning place.
- (8) A thermometer.



FIG. 6.—The rearing room (after Gobin).

Wire, twine, laths, or canes are suitable for the lattice work of the shelves. Make the space between the shelves about 14 inches. If possible, do not arrange the shelves along the wall, and allow a good passage between the tiers of shelves (figs. 5 and 6).

SILKWORM EGGS: HOW TO WINTER AND HATCH THEM.

There are two kinds of silkworm culture: One for production and one for reproduction. The object in the first case is to get the greatest yield of cocoons, and with a little training, may be carried on by anyone of ordinary intelligence.

The aim in culture for reproduction is to secure eggs free from hereditary taint of disease, and experts only can be depended on to conduct it. Besides a careful physiological examination throughout the rearing, the body of the mother moth is microscopically tested after death, and her eggs are not retained if signs of disease are discovered. In this way the birth of healthy worms is insured. Pasteur first applied this method of selecting silkworm eggs, and thus checked the plague (pebrine) which was rapidly destroying silkworm culture in Europe.

Formerly, through an indiscriminate use of eggs, disease invaded the rearings to such a degree that from 65 to 90 pounds of cocoons was considered a good yield per ounce of eggs. At the present low price of silk such cultures are no longer remunerative, and industrial silk culture now demands the exclusive use of scientifically tested eggs.

The grainage, or preparation of eggs for market, constitutes a special department of silk culture. In Italy there are over 400 establishments which supply eggs to raise the annual silk crop. The poorest peasant, though well skilled in the art of rearing silkworms, would not risk a rearing with eggs which have not been selected and preserved by experts.

The eggs of crossed races are best for cultures with a view to production of silk, and here, as much as in the examinations which have been referred to, the knowledge of experts is needed.

The life of the egg, in those races which have but one generation each year, has three phases, the first lasting about three months, full of activity; the second lasting from about October to the middle of February, one of inactivity, in which there are no signs of life; the third from the middle of February to the moment of hatching, in which the vital activity recommences, and the germ begins to organize as soon as the temperature rises a little above 50° F. The measure of the activity of the egg, in this stage, is the measure of its danger, for any sudden change of temperature would injure or destroy the delicate embryo, or cause the larva to be born before its food was ready. To guard against such accidents, eggs must be wintered in a high region or in a refrigerator at a uniform temperature of about 35° F., from December 15, until the mulberry begins to bud or until hatchings are desired. There should always be good ventilation, the air should not be moist, and great care must be taken to keep the eggs out of the reach of mice and insects.

Natural hatchings are almost always irregular, extending over eight or ten days, thus multiplying the divisions and rendering the rearing difficult and costly; hence, the necessity for artificial incubation.

Eighteen days before the time decided on for the hatching, spread out the eggs in thin layers in the incubating room or incubator. The temperature should be 55° F.

From the fourth day on, gradually increase the temperature two degrees in twenty-four hours until 73° F. is reached, when, at this uniform temperature, hatchings will occur in ten days on an average. This period, however, varies from eight to fifteen days, according to race, the cold supported during the winter, the first grade of heat, and the highest during the incubation, and the number of days taken to pass through these two grades of heat; and also according to the humidity. To obtain a good and complete hatching, a slight humidity is necessary, especially during the last four or five days. To secure this keep an open vessel of water near the fire, or sprinkle the floor with water occasionally.

The temperature may be raised during the hatching to 75° F., but sudden changes of heat must be avoided, and, unless the newborn worms can be kept in the same temperature, it is dangerous to have the maximum temperature of the incubator so high.

It is better for the period of incubation to be protracted than suddenly shortened. Holding the eggs at a certain temperature, or slowly lowering the temperature a little does no harm. When the season is not propitious, the hatching may in this way be retarded.

An incubating room is preferable, because it also serves for the first two stages of the worms, but in small rearings an incubator is more economical, both with regard to service and to fuel.

For a large quantity of eggs (5 to 10 ounces) a small incubator, which is very much used in chemical laboratories to dry substances, is recommended. Any ordinary tinsmith can make it. It consists of a double case, cubical in form, with a zinc bottom. The space between the outer and inner walls is filled with water. The front face of the cube is furnished with a glass, so that the temperature within, indicated by the thermometer hanging on the glass, may be seen without the necessity of opening the incubator. There are two openings below on opposite sides to allow the cold air to come in, and an opening in the center of the top to permit the outward flow of the heated air. Having filled the space between the walls with water, the incubator is placed on a support and heated by means of a gas or oil lamp to the desired degree, and, by raising or lowering the flame, a constant or progressive temperature can be maintained (fig. 7). A self-regulating

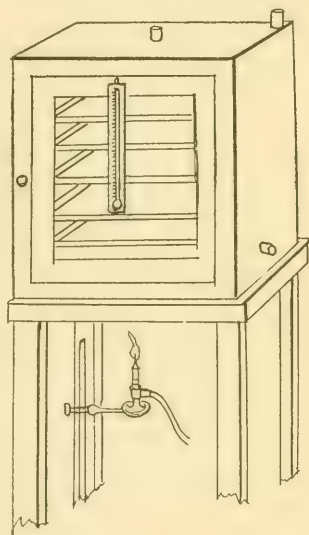


FIG. 7.—Hot water incubator. (Redrawn from Verson and Quajjat.)

incubator, such as is used to hatch chickens, would be more convenient, but would cost more.

The whitening of the eggs denotes the near approach of the hatching. Double pieces of tulle or sheets of perforated paper sprinkled over with finely cut-up white mulberry leaves should then be lightly placed over the eggs to allow the outward passage of the worms as soon as hatched. The object in employing two pieces of tulle or paper is to prevent the unhatched eggs which cling to the sheet from being removed with the newborn worms. This process must be repeated daily during the hatching, the second sheet always being renewed.

The duration of the hatching varies from three to five days, the eggs hatching about as follows: During the first day, 5 per cent; during the second, 33 per cent; during the third, 50 per cent; during the fourth, 5 per cent; during the fifth, 7 per cent.

Twenty-five grams of eggs will give about 17 grams of worms. In small rearings most cultivators raise only the worms that are hatched on the second and third days, to avoid the necessity of forming too many classes. The worms must be classed according to the date of birth, and the insignificant number hatched on the first and last days scarcely compensate for the trouble of rearing them. Different races must also be reared separately.

Where several in one neighborhood are engaged in silk culture it greatly reduces the cost to have all the eggs hatched in one incubator. The person best acquainted with silk culture can undertake the incubation, and distribute the young worms on the second or third days to those who are to rear them. This is the plan adopted among the Italian peasantry, the wife of the supervising farmer hatching the eggs for whole villages.

THE REARING OF SILKWORMS.

Before entering into the details of a rearing some general directions must be given concerning the rearing room—the heating, ventilation, and disinfection.

GENERAL DIRECTIONS.

The place chosen for a rearing should be relatively high, and not exposed to malaria or bad odors, and mulberry trees should grow around it. Any room that can be properly heated and ventilated will answer the purpose. An open fireplace is the best means of heating, but is expensive, as much of the heat is lost. Hot-water pipes, such as are used to heat a greenhouse, are good for a building specially built for silkworm rearing. Iron stoves should not be used, unless placed in an adjoining room with communicating pipes. Never employ charcoal as fuel.

Ventilation.

The domesticated worm should be surrounded continually by pure air. The amount of carbonic-acid gas given out by the worms and their attendants is very considerable; besides this, a quantity of deleterious gas is generated by the litter of the beds, and the lights and fires consume a great deal of oxygen. Myriads of spores and germs of organic life float in the air of the rearing room, and their influence paralyzes the vital energy of the skin and of the organs of respiration, on whose normal functions the robustness of the worm so much depends. Hence, it is evident that the quantity of vitiated air which should be expelled from the room requires the introduction of a large quantity of fresh air. For this, a double system of ventilation is necessary, which may be obtained by double openings in the windows, to allow the heated bad air to pass out above and the cool fresh air to come in below. To renew the air in every part of the room, and to avoid a single and often violent current, there should be more than one window. An open fireplace is the best means of ventilation. When the difference between the external and internal air is slight, or there is no difference at all, artificial means must be used to create a current. Light and frequent fires, or a burning lamp in the fireplace, or a revolving fan, may be used to prevent stagnation of the air.

Disinfection.

Eight or ten days before introducing the worms into their quarters all the shelves and implements should be washed in a solution of chloride of lime (11 pounds of chloride of lime to 88 quarts of water), or in a solution of sulphate of copper (1 to 100 by weight).

When everything is in order—tools, perforated paper, material for the worms to spin their cocoons on, etc., each in its own room—close the doors and windows as tightly as possible and fumigate the rooms with sulphur (11 pounds of sulphur to every 100 cubic yards of space). To fumigate properly, powder the sulphur and place it in an earthen or metallic vessel over a slow fire. The sulphur will gradually melt and take fire. Place it immediately in the rearing room and leave it there, with the doors and windows completely shut, for twenty-four hours.

Nets should not be exposed to sulphur fumes, for this would soon rot them, but should be washed in a solution of sulphate of copper, and immediately afterwards in plain water.

Twenty-four hours after the fumigation the floors should be washed with a solution of chloride of lime or sulphate of copper, and the walls should be whitewashed with lime.

When dead worms are seen on the shelves, change the beds and create in the rearing room sulphurous gas by burning a pound of sulphur during six hours, or make a strong wood smoke, which is a good disinfectant and will not harm the worms.

Wise precaution having been taken to destroy germs of disease in the rearing room, the new-born worms may now be safely installed there.

Space required.

The worms from 1 ounce of eggs should cover at birth 1 square yard. Doubling this space on the fourth day, they would require 2 square yards, and at their change of beds after molting, 4 square yards. By the spacing of the third day of the second age, and the doubling of beds preceding the second molt, they will need for the second age 8 square yards. For the third age 16 square yards will be required; for the fourth age 32 square yards; and for the fifth age 60 square yards. The more space that is accorded to the worms in their first ages, the more robust they will be; and if the space can be tripled instead of doubled during the fourth age, and for the fifth age be 70, 80 or 90 instead of 60 square yards, the harvest of cocoons could be raised from 60 kilograms to 70, 80, or 90 kilograms per ounce of eggs, the quality of silk also being superior.

Temperature.

The silkworm is not a tropical insect, and attains its best development between the temperatures of 68° and 77° F. It is safe to adopt the mean between these two temperatures for the general rearing. Each cultivator, however, may suit his convenience, remembering that to fall below or to exceed the mentioned limits of heat is detrimental to the worm, and will affect the quantity and the quality of its spinning.

From the second age the temperature should be from 70° to 72° F. and should be kept as uniform as possible to the end of the rearing. The time which elapses between one change and the following one may be much shortened by raising the temperature and feeding oftener. Such hasty rearings may be made in twenty two to twenty-four days. They are, however, to be condemned, as contrary to the nature of the silkworm. Meals following each other too closely can not be properly digested, and are likely to cause disease. Besides, hasty rearings require more labor, and the service must be kept up night and day. As there is danger in too high a temperature, so there is danger in one that is too low (64° to 68° F.). A rearing that is too prolonged, lasting over thirty-two days, is to be avoided to escape the heat of June, under which the beds are more likely to ferment, causing disease; the worms have less appetite and leave more leaf from one meal to another; the changes are slower and less likely to occur instantaneously; and there is more risk of muscardine or calcino, a disease due to a mold.

Both hasty and tardy rearings are, therefore, to be proscribed, and those conducted in twenty-eight to thirty-two days alone are recommended. This lapse of time permits the leaves of the mulberry to acquire maturity, and the growth of the worm should be relative to that of the leaf on which it feeds.

THE FIRST AGE.

Hatchings usually occur early in the morning. The worms which have crawled up through the holes of the tulle or paper to get food, should not be removed before 10 a. m. to the laticed shelves covered with paper to receive them. Each shelf must be marked with the date of the birth of the worms put upon it, and care must be taken to place on the same shelf only worms born on the same day, as a remunerative rearing demands that such alone be raised together.

Should the hatching occur at 68° to 70° F., keep this temperature during the first ages, and feed eight times during twenty-four hours; if the temperature at birth is 75° to 77° .. slowly diminish the temperature one or two degrees, and feed ten times in twenty-four hours. The appetite of the worm increases or diminishes with the heat. The second day, in case of the worms hatched at the maximum, adjust the temperature to the degree proposed to conduct the rearing. In feeding sprinkle finely cut up tender leaves frequently over the worms, and toward the fourth day begin to regulate the number of meals so that it will range from four to eight, according to the temperature. Before cutting the leaf remove the stems. Distribute the leaf uniformly and equally on the shelves, in order to prevent the worms from crowding more on one side than another, and in order that they may be equally nourished and make their changes simultaneously. Cut only a small quantity of fresh leaf at a time, and keep the rest in jars or baskets covered with a damp cloth. Never submerge the leaves in water. For the first two or three ages, the white ungrafted mulberry is recommended, it being lighter and more digestible for delicate worms.

It is well during the feeding to open the door and windows to insure a good supply of fresh air. After feeding, close the door and windows, unless the day is warm, when they may be permanently left open, protected by curtains through which the air passes freely. The worms should never be exposed to direct sunlight or to a strong current of air, and during a thunderstorm the windows and doors should be closed.

Worms of the same age and development should be classed together. To obtain this equalization, do not feed newborn worms until all that have been hatched on one day have been removed to shelves, then give a general meal. If at the end of two or three days it is noticed that on certain shelves there are smaller worms than on others, in order to allow the less developed worms to catch up with the more advanced ones, place the former nearer the fire or on the highest shelves, where the air is warmer, and give them one or two more meals than the larger worms. For this reason it is well to have light movable shelves (fig. 5).

Many cultivators of silkworms do not change the beds during the first age, and it is not absolutely necessary, if the leaf has been well cleaned of stems and very finely cut up, and, above all, if the air is dry. Change of bed, however, must be made if the litter is damp, and the weather

rainy, for the worms are going to molt in two or three days, and this crisis should not occur in unhealthy conditions. It is always more prudent to change beds on the fourth day, and is, therefore, advised. The space occupied by the worms must be doubled when the change of beds is made.

The bed on which the leaf and excrement accumulate is, perhaps, the greatest source of danger to the worms. When there is not a free circulation of air, gases are developed which almost always cause fermentation, paving the way for future disease. Hence the necessity for frequent change of beds. This is made in various ways. The practice of doing this by hand is to be condemned because it consumes too much time and is apt to injure the worms. Threadnets (fig. 8) and perforated paper are the best means to employ. They save two-

thirds of the hand labor, and thus allow beds to be oftener renewed, which is a most important consideration. In the first age tulle or mosquito net may be employed instead of nets or paper.

The manner of proceeding is as follows: Place the last meal at night on the nets and extend them over the worms. By morning the worms will have mounted above the opening in search of fresh leaf. Then lift up the nets, beginning at the top shelf, and place them on clean shelves. Carefully detach from the nets any portion of the old bed, and, if the

worms are not molting, gather up the few worms that have remained behind, and tenderly place them with the others. The change of beds is thus rapidly effected with the least labor.

It is very important that the tension of the net be such as to prevent the worms from being crowded together in the middle.

Perforated paper (fig. 9) is another means often used to effect change of beds; but it does not allow the worms to mount with the same facility. It is also apt to break when the worms become heavy, and in many cases it has to be renewed annually, so, in the end it is no cheaper than nets.

In changing beds, do not feed the worms that are first taken up until all from the old bed have been removed; then give a general meal, for all the worms born on the same day and forming one class should

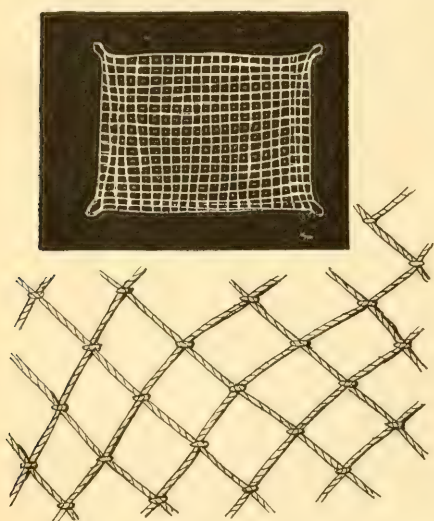


FIG. 8.—Net used in changing beds.

have the same number of meals to preserve their equality of growth, which is necessary for a successful rearing.

Having adopted hours for feeding, these should be adhered to throughout the rearing. When four meals are given, the best hours are 5 to 6 a. m., 10 to noon, 3 to 6 p. m., and 9 to 11 p. m.

Toward the sixth day worms begin to eat less. This is a sign that they are going to molt. Then another change of beds and doubling of space are necessary.

The molt or change of the worm is easily recognized by a swelling of the head, whitening of the skin, transparency of the body, and a fixed position.

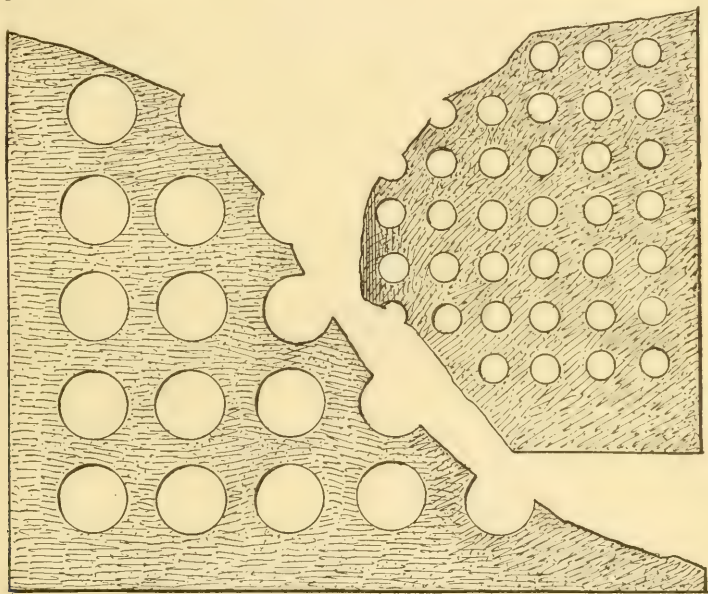


FIG. 9.—Perforated paper used in changing beds in the second and third ages.

To change the beds, proceed as before, only leave undisturbed on the old beds the worms that are molting. When all the tardy worms have been taken up and placed on shelves, give them frequent sprinklings of finely cut up leaf to enable them to catch up with the worms already molting. Diminish the feeding as the backward worms begin to molt, and cease feeding entirely as soon as a single worm comes out of the molt. Then wait twenty-four hours so that the worms may be well over the change before giving a general meal. In this way the equality of development necessary for a methodical and successful rearing is maintained. A fast of twenty-four hours will not hurt the advanced worms, while the extra feeding given to the backward ones may enable them to become equal to the former. The beds of the worms on the old litter may be changed when the general meal is given.

Many cultivators do not change the beds and double the space until after the first molt, allowing all the worms to change in the same bed. In this case, owing to the distribution of leaf for one or two days after the molting has begun, the molting worms are covered by a more or less thick coat of litter, and exposed to emanations of bad gases in a critical period of life, which is likely to cause disease. Besides, in the first age, the worms are so small that they are likely to be lost in the litter, or to perish from suffocation. Hence, it is healthier to change beds and double the space before the molt.

THE SECOND AGE.

The coming out of the molt is announced by the appearance of a small triangular-shaped livid spot on the worm's head, and the changed skin is grayish in color. The worm takes several hours to recover from a change; then it begins to search for food, which, however, as before stated, must not be given before all the worms have recovered from the molt. Then a slight meal is given by means of perforated paper or nets. The worms crawl up promptly and can be easily gathered up and placed on fresh shelves.

If the two sets of worms recover from their molt at the same time, they may be classed together; if there is a difference of a day, it will be necessary to keep them separate throughout the rest of the rearing, for the equality of age has disappeared, and, if they are put together, the second change will not occur simultaneously for all the worms, but will extend over several days, and occasion the greatest trouble to reestablish the equality of size necessary for the best results.

In case no worms have had change of bed before the molt, do not recommence feeding until the greater part of the worms are awake. Do not fear that they will suffer from hunger. Then form a new division of those still molting. It is frequently better to have two divisions, but if, to simplify the work, but one is desired, by putting the backward worms on the highest shelves, and feeding them oftener than the advanced set, an equality may be reestablished.

Three days after the first molt the beds must be renewed, and at the same time more space must be allowed the worms.

The second age is the shortest, being less by two or three days than any of the others. Toward the fifth day of this age the worms begin to molt again. Then act as before—that is, by aid of nets or perforated paper, remove the backward worms, in order to place them elsewhere, and try by more heat and abundant food to make them catch up with the forward worms.

THE THIRD AGE.

The worms double their size in their third age; consequently the space allotted to them must be doubled; that is, they must have 16 square yards instead of 8 square yards, as in the second age.

From the second to the third molt the same care is to be given as has been prescribed for the first two ages, except that, if a small incubating room has been used instead of an incubator, the worms must now be transferred to a larger room to complete the rearing. Care must be taken to heat this room the day before to 80° F., and the next day lower the heat to the degree adopted for the rearing. Feed six times daily either with whole leaves or leaves which are coarsely cut up. For this as well as all the other ages the best rule to follow in feeding is to give only a light sprinkling of leaf at the beginning and end of each age, gradually increasing the ration up to the middle of each age, and then diminishing to the time of a molt. The appetite of the worm will serve as a guide. Give more or less leaf according as the preceding meal has been more or less eaten. In this way leaf will not be wasted and a large quantity of litter will not accumulate under the worms, to their detriment.

Toward the sixth or seventh day of the third age, according to the temperature, the worms begin to be languid and lose appetite, as before, and are ready to make a third change. This is the most difficult of all and the one in which they seem to suffer the most. It is also the period when diseases due to bad eggs or to a poor incubation are developed. Excepting accidental diseases, a good result may generally be predicted if the third change is safely passed. With these facts in view, from the beginning of the third age keep the worms sparse on the shelves and see that the beds are dry and changed with scrupulous care, the litter being far removed from the rearing room. Avoid feeding with wet leaf, and to favor the molting raise the temperature a degree. It will be noticed that the head and body of the worm are more swollen than in other molts. It is this superabundance of liquid that renders this molt so critical and necessitates a drier atmosphere and a bed which is very dry and not apt to ferment.

The worms increase three times in volume after the third molt, and must have space accordingly. They must be separated into three divisions in the following manner: Instead of waiting, as in the first two changes, until half of the worms have begun to molt, let down the nets, or otherwise prepare for the removal of the backward worms when one-third or even less of the worms show signs of molting. About two-thirds will then crawl up on the fresh leaves, and must be placed on a shelf where, after one or two meals, they proceed to molt, being again divided after the first or second distribution of leaves, according to the rapidity of the molting.

If only a few worms mount when the first division is made, the operation was delayed too long, and it is unnecessary to divide those first taken up; but after the change the division of those left on the old bed can be made. To allow the worms to spread out, each division should occupy but one-third of the shelf on which it is placed.

THE FOURTH AGE.

When the worms are over their third molt they cease to be gray, and take the characteristic color of their race. If they are too long in molting it is because the temperature is too low; that is, below 68° F. Increasing the heat a few degrees will excite the worms and enable them to complete their change. After this the temperature adopted for the rearing must gradually be resumed.

When all the worms have molted the third time a change of beds must be made as in preceding ages. Do not be in haste to change. Wait a few hours to permit the worms to recover their strength a little. The recommendation to feed lightly at first applies especially to the beginning of the fourth age.

If the outside temperature is normal, fires need not be kept up, and the doors and windows may be left open, guarded by light curtains. In this age the worms eat enormously and more help will be required to gather and distribute leaf. Small branches of leaf may now be given in place of whole leaves, and the number of meals may be reduced to four, if the temperature is 68° to 70° F., at which temperature the age will last nine days. If it is desired to reduce this age to seven or eight days, raise the heat to 72° F., and give five or six meals daily. Should change of weather retard the growth of the mulberry trees, and temporarily cut off the supply of leaf, adapt the rearing to such a contingency by lowering the temperature slowly to 66° or 68° F., and giving only three or even two meals daily. Then, when leaf is obtained, gradually raise the temperature to the degree adopted for the rearing.

During the fourth age four changes of beds are made, including the one which follows the third molt. A single division of the worms is sufficient, which will be the last, and particular care must be taken to divide the worms into two equal parts. For this, spread the nets or perforated paper over the worms when half are molting and proceed as before.

THE FIFTH AGE.

Do not be in haste to change beds as soon as the worms have molted. This precaution is necessary to allow the new organs to acquire consistency, and to prevent worms from being lost in the litter. Consequently, wait several hours, and change beds after the second meal, the first being only a slight sprinkling of leaves. Worms are not strong enough immediately after a change to digest a heavy meal.

The space during this age should not be limited. See that between two worms another could be easily placed. Experience has proved that the harvest of cocoons is often in proportion to the space accorded to the worms during this age.

Feed from four to six times daily, according to the temperature, and spread the branches or leaves out regularly, not to form a mass. For a simultaneous mounting into the brush all the worms should eat an equal quantity of food.

As ripe berries are very indigestible, and also cause beds to ferment, care must be taken to shake the trees well before gathering the leaves, and whatever ripe fruit remains must be taken off before feeding.

If possible, change beds daily, especially if more than five meals are given, or if the weather is very warm and damp and there are signs of disease.

The first five days after the change the worms grow enormously, and it is very difficult to satisfy their appetite. At the end of this time the body suddenly diminishes in circumference, the excrement, formerly dry and firm, now becomes moist and soft, and the appetite diminishes and becomes capricious. This state generally lasts three days, then suddenly the worm ceases to eat, and tries to get away from its food. It prolongs its head, and, changing its former lazy habit of scarcely moving except to get food, runs about in every direction, stopping from time to time, and moving its head (now transparent gold or white, according to race) like a blind person seeking the way.

These signs indicate that the worm is hunting a convenient place to spin its cocoon. The worm is now mature, and a spinning place should be ready to facilitate its metamorphosis. The humidity, which always exists at this time on account of the mass of litter, is especially dangerous to the worms; and it is increased if the worms do not all mature and mount at the same time, for those that remain below are wet by the liquid dejections of those that are the first to mount. For this reason do not put worms in the spinning place until they are perfectly mature. They then mount, and crawl around some time seeking a favorable place for their cocoons. Finding this they evacuate their digestive canal, and begin to throw around them an irregular net in which the cocoon spun later will be suspended.

PREPARATIONS FOR SPINNING.

A considerable loss may occur in the spinning place even when the rearing has been most successful. To avoid such loss observe the following precautions: (1) Prepare the spinning place in time; (2) arrange it so that the worms may regularly mount, and have abundant room; (3) have it well made, yet economical; and (4) regulate the heat and ventilate the room.

Any convenient dry bushy brush, odorless and free from gum, will serve to construct the spinning place; or if such is not available, bundles of straw, or shavings, or finely split up wood may be substituted. The best and most economical arrangement is small bundles of brush or straw placed upright between the feeding shelves, in rows, about 16 inches apart. The bundles are cut a half inch taller than the space between the shelves, and their tops are spread out to form arches, and to allow the worms plenty of room to spin (fig. 10).

Branches of elm, oak, birch, etc., are used to place the worms in the spinning place. These branches are spread over the shelves at the end

of the fifth age. Very soon they will be covered with mature worms which have ceased to eat, and are turning away from the mulberry. In this way it is easy to select the worms that should be transferred.

If the worms are equally developed, in thirty or forty hours they will be shut up in their cocoons. The few that remain behind should be placed elsewhere; fed with fresh leaf on clean beds they will soon catch up with the others.

The fifth day after the mounting the worms that have not begun to spin should be placed in bundles of twigs and covered with straw or leaves, or put in a basket of shavings, where they will be forced to spin.

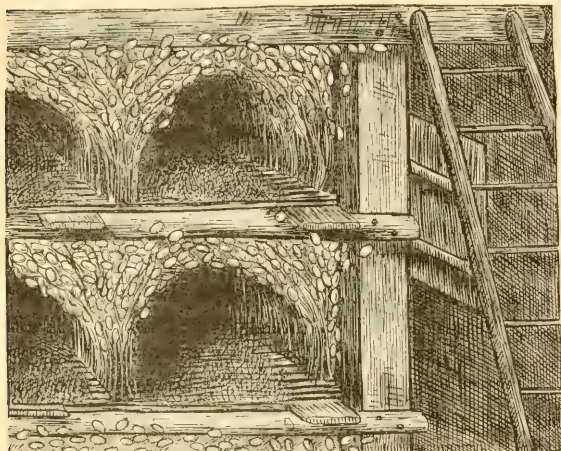


FIG. 10.—Arrangement of spinning places. (Redrawn from Pasteur.)

The temperature during the spinning should be 75° F., and the humidity throughout the rearing about 65° . A good practical test of humidity is a saucer of salt; when the salt is moist, reduce the humidity. Carefully avoid disturbing the worms while spinning, and then, as during all the ages, keep the room as quiet as possible.

The most scrupulous cleanliness should always be observed, both with regard to the quarters and the attendants; to keep from raising dust, wipe the floor with a damp cloth instead of sweeping it.

PREPARING COCOONS FOR THE MARKET.

The transformation of the larva into the chrysalis is, according to the temperature, completed in from seven to ten days from the time at which the first worm begins to spin. The cocoons are then said to be mature, and this is the best time to gather them. If gathered earlier, the producer will run the risk of having his cocoons rejected in the market; and if later, he will sustain a very sensible loss in their weight, as they grow lighter from the time of their maturity until the moth comes out. The best authority estimates the minimum loss as 4.1 per cent, and the maximum as 23.3 per cent. To avoid the risk of soiling them, gather the cocoons from the lowest shelf up. They may be freed from the web or floss by a very simple instrument (fig. 11) or by hand.

After the removal of the web the cocoons are sorted into three classes: (1) The perfect, (2) the double, and (3) the defective or

spoiled. They are then spread out in 4-inch layers, on clean shelves, in an airy, dry room, not exposed to sunlight, and very carefully guarded from rats, mice, and insects. The defective and discolored ones are put in a separate room.

The thread of a cocoon is continuous with that of the web, and diminishes in diameter within. Its length varies from 1,200 yards to 1,600 yards, and its value accordingly. Different races, sexes, and conditions of rearing often produce notable differences in weight of cocoons. Thus the weight may vary from 155 to 320 cocoons to the pound (340 to 700 to the kilogram).

Often two or more worms are inclosed in the same cocoon. Cocoons formed from such collaboration are larger than single ones, irregular in form, and cottony in texture. They can not be unreeled, and consequently are far less valuable than single ones.

The proportion of silk in a cocoon varies according to the race and the régime to which the worm has been subjected. The average normal cocoon at the time it is sold is thus composed:

	Per cent.
Water	68.2
Silk	14.3
Web and veil	.7
Chrysalis	16.8

If the cocoons are not sold as soon as gathered, the chrysalides should be killed without delay unless they are to be reserved for reproduction. Otherwise the moths may pierce the cocoons, thus rendering them unfit to be reeled.

The chrysalides are usually killed either by heat or suffocation. The means most commonly employed are (1) the heat of the sun; (2) hot dry air in a stove; (3) hot humid air in a stove; (4) steam; (5) oil of turpentine; (6) carbon bisulphid or some other gas. Probably the best of these means are steam at a temperature not above 212° F. applied without pressure, or hot damp air at a temperature of 196° F.

The killing of the chrysalides is an important operation and one requiring care and judgment. If some are left alive, the moths will issue, thus rendering the cocoons of little value. On the other hand, if the operation is continued too long, the silk may be injured. The best methods are those in which the heat is carefully controlled and excessive dryness is avoided.

The following is a very simple and easy way to destroy the chrysalides by the use of steam:

Place a cauldron of water on a stove. When boiling begins set over the cauldron a white hollow wooden cylinder, about 3 feet high and 2 feet in diameter, with

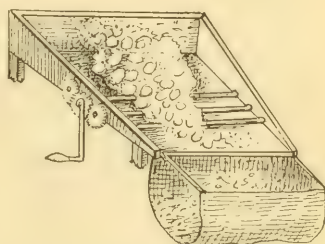


FIG. 11.—Device for removing floss from cocoons. (Redrawn from Nenci.)

a perforated bottom and open at the top. Arrange in this cylinder round baskets three-fourths filled with cocoons; then cover the cylinder with a perforated lid. In about thirty minutes the operation will be completed, after which remove the cylinder, take out the baskets, and spread out the cocoons to dry before storing, to prevent them from spoiling.

Mr. T. A. Keleher of this office has adopted the following plan:

The cocoons are placed in an air-tight box of about 24 cubic feet capacity; about half an ounce of bisulphid of carbon in a small dish is placed in the box and left over night. It is best to open one or two of the cocoons to find if the chrysalides are dead; if not the operation must be repeated. Care should be exercised that no fire of any kind be brought into the vicinity during this operation as the bisulphid of carbon is very inflammable.

In shipping cocoons care must be taken to pack them in baskets or cases permeable to air, but sufficiently close to keep out rats and mice, which are very destructive to cocoons.

DISEASES OF SILKWORMS.

In every successful rearing of an ounce of eggs about 40,000 worms are hatched, and 30,000 succeed in spinning cocoons. The rest either die from casual wounds or from diseases incidental to restricted action. But sometimes whole chambers are destroyed by hereditary and contagious diseases, and it is of supreme importance to cultivators to learn how these scourges may be avoided.

In this limited treatise only a bare mention can be made of the most fatal diseases and of the necessary precautions to be taken to guard against them. The general cause of disease is the domestication of the worm. By using good eggs, however, and following the methods which are actually employed by successful rearers, remunerative results are usually obtained. To obtain good eggs it is necessary to adopt new methods. These are chiefly such as involve the use of the microscope.

Among the many diseases of silkworms, the principal ones are:

Pebrine, flacherie or flaccidity, gattine or macilenza, calcino or muscardine, and grasserie.

PEBRINE.

This disease was first noticed in epidemic form in France in 1845. Since then it has appeared in Italy, Spain, Portugal, Turkey, Turkistan, the Caucasus, Kashmir, China, and Japan, threatening to destroy the silk industry.

Between 1833 and 1865 the annual crop of cocoons in France was reduced by pebrine from 57,200,000 pounds to 8,800,000 pounds. No remedy has been found for the disease, but the Pasteur microscopical selection of eggs, insuring the birth of healthy worms, is a sure preventive. The universal adoption of this method has made pebrine almost a thing of the past; and following Pasteur's line of research, means have now been discovered for avoiding every kind of silkworm disease.

Worms affected with pebrine develop slowly, irregularly, and very unequally. Black spots are the most marked outward characteristics

of the disease; the internal signs are oval corpuscles only visible through the microscope.

Worms healthy born may contract pebrine during life, but this may not prevent their spinning, as the disease does not reach its climax before the chrysalid or moth stage, and in its incipency the worm is strong enough to spin, though the moth will produce diseased eggs. Hence the necessity of repeating the microscopical examination for each generation of worms.

Pebrine is not always visible, and when latent induces other diseases. When only one crop of cocoons is made annually, it is comparatively easy to resist pebrine, as the germ of it, outside of an egg, retains its vitality not longer than seven months. The disease takes thirty days to develop; therefore, if worms from pebrinized eggs can be made to spin within twenty-five days after hatching, they may yield a fair harvest of cocoons. In any case, however, it is only safe to use pure eggs, as pebrine, even in undeveloped stages, renders the worm more liable to contract all other diseases.

FLACHERIE, OR FLACCIDITY.

This is now the most dreaded disease among European silkworms. In general, worms are struck with it after their fourth molt, when they are mature, or even while spinning (fig. 12).

Without any apparent cause, they begin to languish, then remain completely still, and shortly die. They blacken after death (fig. 13), and give out a disagreeable odor. Often entire chambers perish in a day. Again, the progress of the disease may be slow, the worms even spinning their cocoons, but, dying in the chrysalid state, they putrify and soil the cocoon, thus greatly diminishing the value of the harvest. Flacherie is but another name for indigestion. Pasteur and many other scientists assert that flacherie is due to ferments and vibrioni developing in the intestinal canal of the worm; other authorities maintain that the disease may exist independently of these. However, as



Fig. 12.—Worms affected with flacherie dying in the brush (after Pasteur).

these micro-organisms, in the majority of cases, play a prominent part in the development of flacherie, it is well to guard against them.

The principal causes of flacherie are: (1) Eggs being spoiled through careless preservation; (2) hereditary tendency; (3) overfeeding of worms; (4) wet, sweating, dewy, and fermented leaf; (5) leaf submerged in water or full of mud; leaf from a new plantation or from a shaded spot, coarse leaf, or change of leaf; (7) lack of ventilation; (8) excessive heat; (9) dust; (10) keeping worms too thick on trays; (11) accidental deaths of worms from injuries, these putrefying,

and the ferments thus created being communicated to other worms; (12) debility.



FIG. 13.—Worm which died of flacherie, putrefying after death. (Redrawn from Pasteur.)

likely to invade a rearing. To prevent contagion eggs should be dipped in a solution of sulphate of copper before being incubated; and in cleaning shelves and nets, wherever a dead worm is seen, powdered sulphate of lime or copper should be applied.

Unlike the corpuscles of pebrine, the microscopic organisms, which are probably the immediate cause of flacherie, remain alive from one year to another, and the dust of a rearing room may contain them in considerable quantities and become the means of infection. Hence, in cases of flacherie, immediately after the rearing, the walls, shelves, and all the implements should be washed in a solution of chloride of lime or some other germicide, and the room should be fumigated with sulphur.

GATTINE.

The external signs of gattine are indifference to food, torpor, dysentery, and emaciation. It attacks the worm in the first ages, and is especially manifested after a molt. Sometimes it is associated with flacherie, and, in its incipient stage, is confounded with this disease. Later the worm becomes extraordinarily emaciated and sufficiently transparent to be mistaken for a mature larva. The hooks of the prolegs are lengthened out and strongly attach the worm to whatever it touches. Meanwhile torpor creeps on and soon ends its life (fig. 14).



FIG. 14.—Worm emaciated by gattine after the fourth molt. (Redrawn from Nenci.)

Worms having flacherie or gattine do not always die before mounting into the brush, and if the disease has not entirely invaded the organism they may even arrive at spinning. But instead of mounting with the promptness and rapidity of healthy worms, they stop hesitatingly at the base of the brush, then begin slowly to mount, stopping on the first little twigs and distending themselves as though asleep,

sometimes with the head turned towards the base. Again, especially in case of gattine, the worm wanders restlessly here and there, seeking as it were power to eject the silky matter, but too impotent to do more than throw out a scanty thread to weave a web or veil of a cocoon, in which it generally falls and dies.

Eggs free from disease and capable of resistance to disease are the prime requisite in guarding against flacherie and gattine. The moment some deaths are noticed, proceed as follows: (1) Change beds immediately, briskly shaking the worms; (2) place the worms on disinfected shelves; (3) burn the diseased and suspected worms that do not mount on fresh beds; (4) if possible move the whole rearing to another room previously aired and disinfected, and also aired after disinfection; (5) do not feed during the three or four hours in which the change is being made; (6) keep up a little wood smoke in the room; (7) give a few scanty meals of light leaf; and (8) diminish the temperature a little.

CALCINO, OR MUSCARDINE.

This disease, at first, has no visible appearance, but by degrees the vitality of the worm is impaired, and it eats and moves slowly. The body turns rose-colored or red, beginning with the stigmata, and then contracts and loses its elasticity, after which the worm stands still as though paralyzed, and finally dies 20 to 30 hours from the appearance of the first symptoms. After death the body dries up and is covered with a white efflorescence, causing it to look like a stick of white chalk (fig. 15); hence the name of the disease.

Calcino is caused by a mold or minute fungus. There are two varieties of this fungus: *Botrytis bassiana* and *B. tenella*. They both attack the worm in the same way. The spores of the mold by chance get on the body of the worm when it is in a molting condition, and there take root, penetrating below the skin. The thread-like mycelium ramifies until it fills the entire body. Later some of the branches fructify on the surface, and the fruit bursting envelopes the worm with innumerable spores resembling a white powder.



FIG. 15.—Calcinated worm.
(Redrawn from Verson
and Quajjat.)

Each spore is capable of settling on a molting worm and giving it calcino, hence the necessity of taking steps to avoid contagion. Calcino is more contagious than other silkworm diseases. Darkness, stagnant air, dirt, warmth, and moisture are the five things that favor mold, and calcino is due to a mold.

The chief cause of the disease is neglecting to change the beds and keeping litter in and around the room. When only one or two worms

have died from calcino all the shelves should at once be cleaned and divested of dead worms. The floor should be washed with a solution of sulphate of copper (1 to 200 by weight), and a pound of sulphur should be burned, or a strong wood smoke created in the room, which should then be shut up five or six hours, after which the worms should be fed. Should any worms die the next day the beds should again be changed and an ounce of sulphur burned. The quantity of sulphur fumes that would kill rats, bats, and lizards and even human beings does no harm to silkworms. No hesitation, therefore, need be felt in fumigating the rearing room with sulphur; but eggs and thread nets must not be subjected to sulphur fumes. Silkworms affected with calcino die before the moth stage; therefore, it is impossible for the disease to be hereditary. But loose spores of the mold creating the disease may get on healthy eggs. These may be washed off by a good bath of fresh water. Some recommend a bath with a solution of sulphate of copper (one-half per cent of copper). In cases of calcino the room should be disinfected immediately after the cocoons are gathered and the paper and brush used should be burned.

As calcine is never due to infected eggs no attention need be paid to the presence of spores of the *Botrytis* in the microscopic examination to select eggs.

GRASSERIE.

Silkworms having this disease become restless, bloated, and yellow. If punctured they exude a purulent matter full of minute polyhedral, granular crystals.

Grasserie is neither hereditary nor contagious. Unlike pebrine, flacherie, and calcino, it is not caused by microbes capable of multiplying and creating plagues. Grasserie does little harm to silkworms in Europe, but in warm countries, as in Bengal, sometimes assumes an acute form.

leaf, and afterward on young leaf, are migration of large trees is the best means of control. The cause of the sporadic appearance of grasserie is not understood by the Germans at the molting periods. Feeding should not be suspended until the worms have begun to molt, and should not be recommenced until all the worms are well out of the molt; otherwise they are likely to die. The disease often leads to flacherie, and when it occurs in an exaggerated form indicates latent pebrine.

Insects
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L. O. HOWARD, ENTOMOLOGIST.

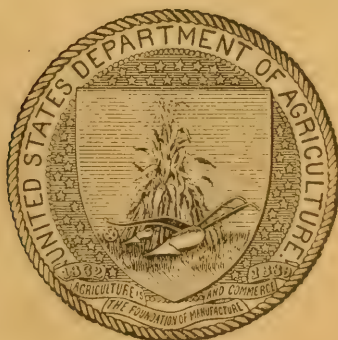
PROCEEDINGS

OF THE

FIFTEENTH ANNUAL MEETING

OF THE

ASSOCIATION OF ECONOMIC ENTOMOLOGISTS.



WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1903.

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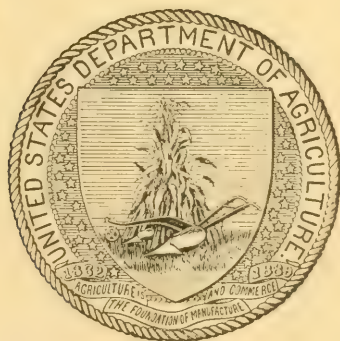
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DIVISION OF ENTOMOLOGY.

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LETTER OF TRANSMITTAL.

UNITED STATES DEPARTMENT OF AGRICULTURE,

DIVISION OF ENTOMOLOGY,

Washington, D. C., March 29, 1903.

SIR: I have the honor to transmit herewith the manuscript of the Proceedings of the Fifteenth Annual Meeting of the Association of Economic Entomologists, which was held at Washington, D. C., December 26 and 27, 1902. The papers presented at this meeting are of an unusually practical nature, and the discussions bring out facts of considerable importance. I therefore recommend the publication of this report of the Proceedings as Bulletin No. 40 (new series).

The term "new series," applied to these bulletins, will be omitted after this number, as it is no longer necessary to distinguish them from the bulletins of the old series, which included only 33 numbers.

Respectfully,

L. O. HOWARD, *Entomologist.*

Hon. JAMES WILSON,

Secretary of Agriculture.

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FIFTEENTH ANNUAL MEETING OF THE ASSOCIATION OF ECONOMIC ENTOMOLOGISTS.

MORNING SESSION, FRIDAY, DECEMBER 26, 1902.

The Association met in the natural history room, third floor, main building of the Columbian University, Washington, D. C., at 10 a. m., December 26, 1902.

The following were in attendance:

W. B. Alwood, Blacksburg, Va.; W. H. Ashmead, Washington, D. C.; C. F. Austin, Collegepark, Md.; H. A. Ballou, Amherst, Mass.; Nathan Banks, Washington, D. C.; H. S. Barber, Washington, D. C.; Frank Benton, Washington, D. C.; J. Chester Bradley, Philadelphia, Pa.; A. F. Burgess, Columbus, Ohio; W. E. Burke, Washington, D. C.; August Buseck, Washington, D. C.; A. N. Caudell, Washington, D. C.; D. W. Coquillett, Washington, D. C.; E. P. Felt, Albany, N. Y.; H. T. Fernald, Amherst, Mass.; W. F. Fiske, Atlanta, Ga.; James Fletcher, Ottawa, Canada; G. H. Harris, Washington, D. C.; Otto Heideman, Washington, D. C.; J. S. Hines, Columbus, Ohio; W. E. Hinds, Washington, D. C.; A. D. Hopkins, Washington, D. C.; L. O. Howard, Washington, D. C.; V. L. Kellogg, Stanford University, Cal.; J. Kotinsky, Washington, D. C.; C. L. Marlatt, Washington, D. C.; B. Pickman Mann, Washington, D. C.; George W. Martin, Nashville, Tenn.; Herbert Osborn, Columbus, Ohio; Theodore Pergande, Washington, D. C.; J. L. Phillips, Blacksburg, Va.; F. C. Pratt, Washington, D. C.; A. L. Quaintance, Collegepark, Md.; F. William Rane, Durham, N. H.; P. H. Rolfs, Miami, Fla.; W. E. Rumsey, Morgantown, W. Va.; E. A. Schwarz, Washington, D. C.; C. B. Simpson, Washington, D. C.; Henry Skinner, Philadelphia, Pa.; T. B. Symons, Collegepark, Md.; Mrs. Henrietta T. Walcott, Boston, Mass.; F. L. Washburn, St. Anthony Park, Minn.; J. L. Webb, Washington, D. C.; Wesley Webb, Dover, Del.; C. M. Weed, Durham, N. H.; E. V. Wilcox, Washington, D. C.

The meeting was called to order by the president, Dr. E. P. Felt, who, after calling Mr. Herbert Osborn to the chair, the vice-president being absent, delivered his annual address, which follows:

THE LITERATURE OF AMERICAN ECONOMIC ENTOMOLOGY.

By E. P. FELT, *Albany, N. Y.*

Publication is undoubtedly our most important function, and while discussions of methods and lines of research may modify the matter made public, it seems to the speaker that a consideration of the form and method of publication may not be without value. This subject, it is true, has been mentioned more or less by my predecessors, and

was discussed somewhat in detail by Dr. Forbes in 1893 and by his successor, Dr. Howard, in 1894. The address of the former constitutes one of the most critical analyses of a portion of our literature and of methods of publication, while that of the latter is an exceedingly complete record of what had then been published in economic entomology in this country and abroad. Dr. Forbes had occasion in 1893 to call attention to the fact that the literature of American economic entomology was increasing with great rapidity, and this has been even more manifest in later years. Somewhat over 10,000 newspaper articles about injurious insects have been published since 1860, while a rough estimate of the number of octavo pages devoted to the subject gives us a total of nearly 50,000, of which about one-quarter are found in bulletins of the agricultural experiment stations, and were therefore published since 1888. It is impossible to discuss this literature in detail within the time at our disposal, and only a few of its more salient characteristics can be brought out. It seems to the speaker that this is not the place for destructive criticism, and the following is presented in hopes that it may suggest methods whereby we may render our work of greater value to the general public. It is also well known to the speaker that his hearers are undoubtedly obliged to modify their publications, more or less, on account of conditions over which they have comparatively little or no control.

Dr. Forbes, as a result of carefully examining over 115 articles in 1893, came to the conclusion that economic entomologists were advancing more as a body of irregulars than an organized soldiery, and he drew from these publications the inference that we as a body were fairly well satisfied with our present methods of investigations; or, if not, at least were not in a condition to improve them at the time. He also failed to find a record in those publications of any new method of research, either adopted or proposed, in either field or laboratory; nor did he observe any noticeable departure from the stereotyped form of presentation, and he concludes that our methods of report and publication of dissemination and enforcement were lagging far behind our methods of research, and were receiving far too little attention. He also calls attention to the fact that we are very likely to forget that we are writing for the men to whom entomology is a perplexing, obscure, and displeasing subject, of which they know little or nothing good, while on the other hand they are frequently experts in crop inspection, and far quicker, as a rule, to observe injuries to their crops than are we, and much more likely to discriminate between them. He argues from this that crop injury and its characteristic appearance should lead in our discussions of injurious species, closely followed by remedial and preventive measures, and that a description of the insect and an account of its life history should be awarded a subordinate place, especially in monographic accounts, and calls attention to the

comparative inefficiency of miscellaneous collections of articles, such as comprise the bulk of most reports and bulletins, so far as reaching the public is concerned.

The economic entomologist of America can not be charged with lack of energy and thoroughness, particularly when a species inflicts enormous losses upon staple crops.

A brief résumé of the literature reveals the somewhat surprising fact that over 1,825 octavo pages have been occupied by various writers in discussing the Rocky Mountain locust. The next insect to approach in importance this very serious pest, so far as the extent of the literature devoted to it is concerned, is the comparatively recently established San Jose scale, accounts of which already fill 1,160 pages. This species is closely followed by the excellent reports and the exhaustive monograph on the gypsy moth, comprising a total of 1,154 pages. The chinch bug comes next in importance, if we may judge of its rank by the 1,032 pages devoted to a discussion of it by various writers; and this is closely followed by the cotton worm with 908 pages, which is frequently treated of with its associate the bollworm, so that the two have monopolized 1,328 octavo pages. The codling moth is one of our older insects, and it is perhaps not surprising that 887 pages have been devoted to a discussion of its habits and the methods of controlling it, while the Hessian fly, also an early importation, has an extensive literature of over 629 pages. The periodical cicada has a literature extending over 647 pages, while 100 bulletins or separates, comprising 1,624 pages, are largely devoted to discussions of insecticides and apparatus for their application.

The estimates given above are only approximate, and have been rigidly limited to articles appearing in the more permanent bulletins and reports, no account being taken of newspaper articles. The entire literature of any one of these insects must be much more extensive than indicated by the above figures. It is probably impossible to avoid the somewhat extensive duplication of work represented by these figures, because the entomologist of each State is obliged to meet the demands of his constituents, and it is therefore frequently necessary to republish many well-known facts.

The monographic accounts of these species serve a very useful purpose in showing how much there is to be learned concerning each insect, and afford worthy models to inspire the investigator engaged in studying the life histories and habits of less known forms.

NEWSPAPER AND MINOR ARTICLES.

An estimate based on the bibliographies of American economic entomology and a calculation of the number of articles published between January 1, 1900, and December, 1902, gives the enormous

number of 12,163 articles issued since 1860. This estimate includes not only newspaper articles, but also most, if not all, of the reports and bulletins published by American entomologists, and at the same time it probably omits a number of articles worthy of enumeration in this list. Undoubtedly some of the articles are practically duplications of others, and yet, after making all due allowance, we can hardly admit that less than 10,000 minor articles have been prepared for the public press by American entomologists during the last forty-two years. This is an enormous number, and despite the fact that some consider newspaper entomology as of little importance, the speaker can not help feeling that this mass of literature represents a very important part of the work of the economic entomologist. Reports are issued for the public, bulletins are prepared for the general dissemination of information, but the man who wishes to learn concerning an insect pest is much more apt to read his agricultural or local paper than to go to his bookshelves and search for some report or bulletin which may contain the desired facts. In other words, the speaker is inclined to believe that our newspaper and minor articles are much more generally read than the more detailed notices given in reports and bulletins, and on this account he considers newspaper entomology a very important factor in developing our work, and believes that all articles prepared for the press should receive careful attention and be adapted to the readers of the periodical. The attention of scientific men is not infrequently called to ridiculous statements concerning scientific facts in daily or weekly papers. Such are not calculated to inspire respect for the publication, and yet do they not indicate an opportunity of which we may avail ourselves? They show that the publishers recognize the demand for scientific information. The paper attempts to meet it in much the same way as it supplies information concerning many more familiar things. The reporter, who is of value in working up the account of a railway wreck, may fail when he discusses the life history of an insect; and we, as economic entomologists, should undertake, so far as possible, to supply this demand with concise popular accounts, giving the facts which the people wish to know. We can never entirely suppress sensationalism, but we can exert a strong influence toward moderation, and the speaker is of the opinion that most agricultural journals of America have already come under its influence, and as a rule apply to reputable parties for information, rather than rely upon unknown sources. The work begun with the agricultural and horticultural press can be gradually extended till most of the reputable weekly and daily publications of our country recognize the necessity of securing accurate information regarding various phenomena in natural history, and insist upon placing such before the public. This desirable end, however, will be brought about gradually, and will be hastened in proportion as

we appreciate the importance of the subject and give these popular articles the necessary attention. We can not expect the public to appreciate the desirability of accurate information on this subject if those who pose as authorities are content to give out inaccurate, undigested, poorly worded articles in answer to queries. The agricultural and daily press of America is worthy the best we can give it, and in proportion as we meet that demand will we be successful in extending the influence of the work in which we are interested.

REPORTS.

Aside from newspaper articles, this form of publication has been the first employed in economic entomology. The earliest report is that by Dr. Thaddeus William Harris, of Massachusetts, whose classic writings form the basis of all subsequent work in this branch of natural history. There is no necessity for the speaker describing or praising this work, since his hearers are all familiar with it, and it suffices to call attention to the fact that Dr. Harris's work is really a practical systematic account of the more important species known at that time.

The admirable series of reports prepared by Dr. Asa Fitch, entomologist of the New York State Agricultural Society, and practically State entomologist of New York, are equally well known and contain a mass of information with which every worker in this branch must familiarize himself if he would succeed. The arrangement of the reports by Dr. Fitch is very different from that obtaining in Dr. Harris's treatise and consists in a systematic grouping of the insects under important food plants. Dr. Fitch evidently believed in making his writings accessible to those who were not entomologists and who had no special interest in the subject. His reports form the beginning of a series which in reality was continued by Dr. Lintner, though in different form, the latter's reports being composed very largely of detailed accounts of species which had come prominently to notice during the period the report covered. These individual accounts are almost invariably grouped systematically and are in many respects models in their thorough, lucid, concise treatment of injurious species.

The series of reports and other entomological publications by the Federal Government was begun by Townend Glover in 1854 and has continued, with a few breaks, in one form or another to the present day. The work of Glover was seriously hampered and his reports, while containing a mass of valuable information, were far from what he would have made them had conditions been more favorable. It will be observed, however, that he evidently planned his work with the intention of ultimately reaching the desired end, no less than that of giving popular economic accounts of all of the more important groups of insects. For example, his report for 1867 is concerned largely

with the food habits of beetles, that of 1875 with the Heteroptera, that of 1876 with the Homoptera, and of 1877 with the Hymenoptera.

His work was continued by the late Dr. C. V. Riley, of whom all of us know, and to whose writings coming generations of economic entomologists must constantly refer. Dr. Riley began his work in Missouri and his nine reports issued there from 1869 to 1877 have been characterized by Dr. Howard as forming "the basis for the new economic entomology of the world." These reports are original, practical, scientific, and include a multitude of facts and intelligent deductions which have had a potent effect upon the science. The work begun in Missouri was ably continued in the United States Department of Agriculture, with the exception of an unfortunate break of two years, down to the untimely death of this gifted scientist. His work in the Department of Agriculture was in many respects a continuation of that begun in Missouri, and the large amount of information gathered and published is most remarkable. The reports of this man are largely composed of independent accounts of various species coming prominently to notice from year to year. Dr. Riley's skill with the pencil and his accurate delineation of insect life has added very materially to his reputation.

The later work of the Division of Entomology has been continued by one with whom we are well acquainted, and at present we will leave his work and turn to a consideration of other reports.

The magnificent series of volumes on economic entomology prepared by the State entomologists of Illinois contain an immense amount of information and will ever remain enduring monuments to their writers. There are special features in this series of reports which are worthy of mention. Dr. Le Baron began in his third report his *Outlines on Entomology*, which was continued in his fourth, and Dr. Thomas in the sixth report began a series of papers designed to form a popular account of the entomology of the State, particularly of those species of economic importance. His successor, Dr. Forbes, has given us several papers of noteworthy value. His twelfth report includes a discussion of the food relations of predaceous beetles, and the appendix to the fourteenth is an index to the twelve earlier reports. The fifteenth and sixteenth give much space to a detailed consideration of the chinch bug, and the seventeenth contains an analytical list of the entomological writings of Le Baron, and renders his work more accessible to other writers. The eighteenth report contains an admirable monograph on insects injurious to Indian corn, and the nineteenth is devoted largely to a monographic account of the work with chinch-bug fungus, the appendix comprising a detailed study of the Mediterranean flour moth by Professor Johnson.

The State entomologist of New Jersey has issued a series of reports since 1890 which contain a mass of original observations concerning

insects injurious during the various years. These accounts are grouped under important food plants as a rule. Exceptional features are that his report for 1893 contains a brief general account of the more injurious species belonging to all orders, and that for 1895 an interesting and valuable paper on the Relation of Insects to Fruits. Later reports give much space to crude petroleum as a remedy for San José scale.

The late State entomologist of Minnesota, Dr. Otto Luggler, began a series of reports which promised, when completed, to form a remarkable contribution to the entomology of America. His second report treats of parasites of man and domestic animals, the third of the Orthoptera, the fourth of Hemiptera, the fifth of Coleoptera, the sixth of Lepidoptera, and it is stated that the manuscript treating of the Diptera^a was nearly completed at the time of his death. It is certain that had this series of reports been carried to an end, America would have been favored with one of the best general works on practical entomology which has yet been issued.

The reports of the Entomological Society of Ontario, beginning in 1870 and extending to date, is a remarkable series of publications, replete with interesting and valuable observations by many writers upon the economic insects of that section. These reports, and those from 1884 to date, of Dr. James Fletcher, entomologist and botanist of the Central Experimental Farms, include most of our records concerning the insects of the northern part of America, and are composed largely of original observations and exceedingly practical recommendations and deductions from observed facts.

It will be seen from the above that the reports of various State entomologists differ widely one from the other, and that within certain limits at least a considerable choice is admissible. There has been of late years a marked tendency toward specialization, which is perhaps as well exhibited in the publications of the United States Department of Agriculture as anywhere. The report of the Entomologist, which was formerly a contribution of some 200 or 300 pages, has been cut down and comprises relatively few pages devoted to a general discussion of conditions. The entomological matter formerly appearing in the report has been subdivided and is made public either as special papers in the Yearbook or as bulletins treating of some special subject, which may be either economic or systematic. It seems to the speaker that generally speaking this is a step in the right direction. The general public is not interested in entomology itself, and will read bulletins or reports on the subject only when some practical end is served. It must, therefore, be approached from this point of view. The speaker has been impressed for some years with the

^aSince reading the above Professor Washburn has informed us that he has failed to find any such manuscript, and if it ever existed it has probably been lost.

idea that extended reports on entomology, while they contain a great deal of very valuable and useful matter, do not appeal to the public mind, and he is therefore inclined to think that wherever conditions will admit our publications should be of a special rather than of a general character. The annual report on entomology, wherever it is possible to have one, is a very convenient method of publishing observations and other records which could not be properly included in a bulletin, and such reports should have a limited circulation. They are more for the economic entomologist, the one who wishes to go back to original sources of information, and do not appeal to the general public.

There are, however, special reports on well-defined economic groups, which are of greatest value to the general public and of utmost utility to the nation. I refer in particular to such works as Hubbard's *Orange Insects*, Comstock's *Cotton Insects*, the reports of the United States Entomological Commission on *Rocky Mountain Locusts*, and Dr. Packard's report on *Insects Injurious to Forest and Shade Trees*, and to the monographic report on the *Gipsy Moth*, by Messrs. Forbush and Fernald. These are the highest form of report, and, when properly prepared, constitute an exceedingly valuable record concerning species of great economic importance. Such works as these appeal not only to the practical or economic entomologist and the systematic worker, but also to every man interested in the crops or products affected by the insects treated. Such work as this adds very materially to the prestige of economic entomology in America, and will continue to do so just as long as the parties engaged in such efforts are well qualified and possess the high ideals governing those who have gone before.

BULLETINS.

Next to newspaper articles, bulletins appear best to reach the popular mind. The first important bulletin on economic entomology, so far as known to the speaker, is No. 1 by the United States Entomological Commission, which was issued in 1877, and which was followed by six others, five being devoted to popular accounts of specially injurious insects or groups of insects, and the other, No. 6, being a detailed index and supplement to the classic Missouri reports previously mentioned. This latter, therefore, in reality helped to render more accessible a mass of earlier published observations. This series of bulletins was closely followed and overlapped by a series begun under the authority of Dr. Riley, then chief of the Division of Entomology, United States Department of Agriculture, and continued through 33 numbers. This earlier series has been followed by a second series, which already includes 38 popular and 9 technical bulletins.

About 400 entomological bulletins have been issued in America by various State experiment stations and other public officials charged

with the study of entomology, and the limited time prevents their discussion in detail. These publications, however, may be grouped as follows:

1. Popular brief accounts of individual insects or groups of insects of economic importance.
2. Monographic accounts of individual insects or groups of insects of economic importance.
3. Technical bulletins.

There are a number of advantages and some disadvantages in the use of bulletins as a medium for rendering information available. These publications are not so permanent in character and unless carefully bound by the recipient are liable to be lost or even worn out by constant use. On the other hand, the bulletin usually permits a much more prompt publication than is possible with the annual report and in addition allows a much more elastic grouping of matter. This of itself is of considerable value, particularly when publications are used, as many of us do use them, to answer queries in regard to this or that insect. If we have a bulletin treating only of the species involved, it will usually answer every question, while if we send a report, which may include accounts of a number of other insects, the treatment of the one under consideration may or may not be full enough to answer the requirements of the case; and an additional disadvantage in sending reports is that we may be obliged to transmit a mass of matter which has comparatively little or no interest to the recipient. The bulletin is therefore desirable whenever we wish to publish promptly and economically.

It is very difficult to define the scope and character of the popular bulletin. Generally speaking, it should be brief, concise, and contain very little more information than is necessary for the practical fruit grower or horticulturist who wishes to control the species in question in an intelligent manner. This means that many details, which are of considerable value to the systematic student and the biologist, must be rigidly excluded. These brief popular bulletins may, as previously mentioned, treat not only of one insect but of an economic group, and it seems to the speaker that the latter in the long run are bound to be more successful and beneficial. He has been informed, for example, that the excellent publication on Household Insects, Bulletin No. 4 (new series), Division of Entomology, United States Department of Agriculture, is very popular and that the demand for it is simply enormous.

There is another form of the brief popular bulletin which is exceedingly well represented in the circulars issued by the Division of Entomology. These, as we all know, are very brief accounts of individual species and are exceedingly useful in answering queries from time to time. Such circulars are abridged from fuller accounts, and this

form of publication has been used by a number of entomologists with a great deal of success.

Another device for the popularization of scientific matter has been adopted by the New York State agricultural experiment station at Geneva and consists in prefacing every bulletin by a very brief synoptic account of its contents, and, in not a few instances, there is a popular edition of the bulletin as well as an extended one. This popular edition is very little different from a circular treating of an individual species except that the popular bulletin includes the same field as the more extended publication, whether that treats of a single insect or a group of insects.

Monographic economic accounts of insects are exceedingly valuable, and are absolutely necessary to the advancement of the science. Recent years have witnessed the issuing of a number of noteworthy publications of this character, among which may be mentioned Slingerland's account of the codling moth, Card and Gillette's studies of the same insect, and other bulletins of a similar character. In such publications as these, we should have a summary of all that is known, together with a mass of original information. This work is absolutely necessary, and probably the best method of making it public in the majority of cases is by the use of the bulletin. These bulletins, however, must of necessity be published at irregular intervals, and therefore can have little connection one with the other.

This scattered method of publication has serious disadvantages and the monographic accounts of economic groups are designed to remedy this evil. We have a number of noteworthy publications illustrating this line of effort, among which may be mentioned Forbes's excellent account of insects injurious to indian corn, Forbes and Hart's economic entomology of the sugar beet, Slingerland's climbing cutworms, and others of like character. Such publications appeal to the popular mind because, as a general rule, they approach the subject from the aspect of the practical grower, and are of more general service than the detailed monographic accounts of individual insects.

The technical bulletin is a publication of entirely different character and is, or should be, designed almost solely for the use of the economic worker and not for the general public. These bulletins are usually issued in limited editions and sent only to those who can use them to advantage. They may be and frequently are largely systematic in character and should include monographic accounts of considerable economic importance on such subjects as parasites, leaf feeders, borers, etc. Excellent representatives of these are seen in Howard's Study of Insect Parasitism, Marlatt's account of Nematinae of North America, Coquillett's Revision of the Tachinidae, and Hunter's Aphididae of North America. Such works as these, though frequently embodying much systematic and biologic work which apparently has

no direct bearing upon the practical aspect of economic entomology, are absolutely necessary as a basis for further work. These more technical studies are in reality of equal if not greater value in developing economic entomology than the more popular practical accounts which are prepared for the general public. It is true that they are accessible to and read by fewer individuals, but these individuals are the parties who prepare the popular accounts and make free use of the more technical matter wherever it can be employed to advantage, so that in reality the public receives full benefit from any such publication.

JOURNALS.

The various entomological journals published from time to time contain more or less economic entomology, only one of which can be mentioned at this time. The economic department in Entomological News, conducted by Dr. J. B. Smith, was instituted a number of years ago by Dr. Skinner, and affords an opportunity for the prompt publication of shorter articles and is a valuable feature of the periodical. There are three journals which have been devoted entirely to economic entomology. The Practical Entomologist, which ran through two volumes, and the American Entomologist, which completed three, are the only instances of publications supported in part at least by subscriptions which have been devoted very largely to economic entomology. The shortness of their lives is eloquent of their lack of support. A unique serial, devoted entirely to economic entomology and independent of subscribers, was issued by the Department of Agriculture under the joint editorship of the late Dr. Riley and Dr. L. O. Howard and is well known to every worker in the science as "Insect Life." There is perhaps no other publication which contains so much original information concerning entomology within so limited a space as these seven volumes. The numbers were issued approximately monthly. The editor was the Chief of the Division of Entomology, and as he was supported by an able staff of assistants, not to mention the entomologists of the entire country, there was nothing in the publication which was not reliable, and the effect upon the development of the science was extremely beneficial. It afforded a ready medium for the announcement of interesting and valuable discoveries and received the hearty support of every worker in the science. The monthly issue of the numbers kept every entomologist informed regarding the doings of his associates and served as a general stimulus to all. We can but regret that it was necessary to discontinue such an admirable publication, and while its loss is in part made good by the most excellent series of bulletins issued by the Division of Entomology, still there are features in the periodical which have not been, and probably can never be, made good by the issuance of bulletins at

irregular intervals. This series of bulletins can never command such a general support of working entomologists as a publication issued at regular intervals, and consequently, with the discontinuance of *Insect Life*, economic entomologists lost a ready means of communicating one with the other, and the speaker feels that the development of the science has been hindered by its suppression. A publication dependent upon subscription can never fill the place occupied by *Insect Life*, since it must cater to its readers and give considerable space to well-known facts, whereas a publication independent of subscribers can follow a definite plan and restrict its matter to that which is original or of great value on other accounts.

GENERAL WORKS.

There are several general works on economic entomology which have been published, aside from reports and other official publications by State or station entomologists. One of the earliest and the best in a great many respects is Saunders's *Insects Injurious to Fruits*. The injurious species are grouped, according to the part injured, under important food plants. Each account, while brief, gives a résumé of the more important facts concerning the species.

The early edition of Professor Saunders's work was closely followed by Cooke's *Injurious Insects of the Orchard, Vineyard, etc.*, a work which covers the entire field of economic entomology in less than 500 pages. The treatment of each species is necessarily brief, and while the accounts are grouped according to food plants the systematic position of a species and its synonymy are indicated. The work was prepared particularly for the use of fruit growers and vineyardists in California, where it appears to have found its principal sale.

Dr. Weed's *Insects and Insecticides* (1891) treats of the more important injurious insects and methods of controlling them in a volume of less than 300 pages. The limited space made a rigid selection imperative, and the account of each species is brief. It is an exceedingly valuable work, and the following year was followed by Kellogg's *Common Injurious Insects of Kansas*, which covered the same field as the preceding work. The treatment is a little different, and a feature worthy of special mention is the brief diagnosis preceding the account of each species. Dr. Smith's *Economic Entomology* (1896) is a work prepared along very different lines from the preceding, and gives brief practical accounts of all the more important injurious insects within the limits of 466 octavo pages. The various accounts are necessarily limited and the arrangement is systematic, a discussion of the injurious or beneficial species of the different orders being preceded by a brief account of ordinal and family characteristics.

The same year *The Spraying of Plants*, by Lodeman, appeared, and while the scope of the work is greater than that of entomology, much

of the latter is included. The most prominent characteristic of the volume is its great condensation, more facts being included within its 400 pages than perhaps in any other volume of its size.

The present year has been marked by the appearance of *Fumigation Methods*, by Professor Johnson, a monograph of the application and uses of hydrocyanic acid gas, and by the publication of Sanderson's *Insects Injurious to Staple Crops*, which latter is prepared on somewhat similar lines to Saunders's *Insects Injurious to Fruits* and covers its field more fully than has hitherto been done.

INDEXES.

The literature of American economic entomology has become so extended that detailed indexes are an absolute necessity; otherwise many valuable records are lost, so far as the busy worker is concerned. The first general index published was that to Riley's nine Missouri reports, and in many respects it is a model publication. It is not only very detailed, but every insect is indexed by its specific as well as its generic name, something which the speaker is inclined to think of great importance. The many changes in nomenclature make it very difficult for a person to keep up with them, and the index which lists a species by its specific as well as generic name aids materially in this respect. This publication is perhaps open to one criticism, in its having separate indexes for plants and insects. This is to some extent a matter of taste, and yet the speaker is inclined to believe that the general index, including all references, is superior, since no question can arise as to which index is before the seeker for information. This is something which used to trouble my distinguished predecessor not a little and my hearers are probably aware that all the later indexes prepared under his direction have included every reference.

The next general index to appear was that by Professor Forbes of the first twelve reports of the State entomologists of Illinois. This is prepared on very nearly the same lines as that to Riley's Missouri reports, and is also open to the criticism of having separate indexes for plants and insects. It is, however, admirably gotten up and has proven of great value to working entomologists, since it renders more accessible the vast amount of information recorded in these reports.

Neither of these general indexes, or the later one prepared by Dr. Lintner, have aided in making accessible the vast amount of information annually published in newspapers, bulletins, reports, or other publications by the economic entomologists of America. This literature is widely scattered, and the preparation by Mr. Henshaw of a bibliography of the more important writings of Messrs. Walsh and Riley made way for general indexes to the publications of other American writers on economic entomology. My hearers are all familiar with the admirable series of bibliographies prepared under the auspices

of the United States Department of Agriculture, Division of Entomology, which have rendered this vast literature accessible to economic workers. It is only a question now of consulting a few indexes, and the average worker, if he has an adequate library at his command, can easily learn what has been recorded concerning injurious species under consideration. If one were to criticise these publications at all, it might be allowable to suggest that the indexes be made a little more detailed, particularly in the later publications. The addition of references to specific as well as generic names and to food-habit records would materially increase the value of the volume without greatly extending its limits.

The general index to that magnificent series of volumes known as "Insect Life" has proven an invaluable publication to almost every economic worker, and our hope is that in the future we will see more such aids to research.

Indexing is to some extent a thankless task, and yet a very necessary one if we would keep abreast of the times. The value of the index lies not in its length, but in its usefulness, and the speaker has always felt that it was by all means advisable to index all important references, at least, under several names, wherever that could be done with propriety. No two men think alike, and an index should be made for the use of all. Some approach a subject from one side, others from another, and unless the index is general enough to include all it is liable to be comparatively useless to a great many. The speaker is of the opinion that the general index should include, as previously stated, references to generic, to specific and common names, to food plants; and every index of a series of volumes should also include illustrations, preferably under a general title, such as figures, because it sometimes occurs that a worker is searching for a good illustration, and if by turning to a few general indexes and looking under figures he can find where all such have been published it is an immense aid.

It is impossible to lay down any fixed rule as to what references shall and what shall not be included in an index. This depends somewhat upon the character of the work. In general, the speaker believes that every isolated fact not specifically included in the title of the publication should appear in some form in the index, if the object of the index is to make accessible the contents of the volume. The speaker is gratified to observe that some of our more recent bulletins are being indexed, and while there are undoubtedly publications of this character where an index is superfluous, in a great many instances it is of decided value and should be incorporated wherever circumstances permit.

A table of contents is also of much value and adds considerably to the completeness of any publication. It need not be an extended one unless the work requires it, because a very brief summary may

include everything that is desirable. It is not necessary to devote an entire page to the table of contents and the speaker can not but commend to his hearers the plan of the university of the State of New York of placing on the cover page of its bulletins a brief summary of the contents. It requires little space, is conspicuous, and usually meets every requirement.

The above discussion of the various forms of publications and the purposes which they serve has been entered into because the subject is one of prime importance, and while undoubtedly each of us has given the matter consideration before, it may be that a joint discussion will bring out facts of value. The speaker recognizes the limitation imposed upon various entomologists and is well aware that it is not always practicable to choose between different forms of publication. Each institution usually has certain methods which have become established through years of usage and there is more or less difficulty in securing a change. The advantage of discussing the matter on this occasion is that whenever a change is possible we may know how to use it to the best advantage. The ideal scheme of publication, it seems to the speaker is about as follows:

1. Newspaper articles.
2. Brief popular circulars.
3. A little more extended but brief popular bulletins, treating of economic insects or groups of insects.
4. Monographic popular accounts of economic insects or groups of the same.

It seems to the speaker that if the science is to be advanced in the future more attention should be paid to monographic accounts of economic groups. These should be extended enough to include most of the forms of importance, and at the same time give references to more detailed accounts of each species or group of species, so that the student more deeply interested in the subject can continue his studies further.

5. Reports containing records of activity and such other matter as can not be conveniently grouped in a bulletin or special treatise.

6. Technical bulletins or systematic accounts of natural groups of greater or less importance.

We all recognize the fact that systematic and economic entomology can not be separated one from the other. They are joined together by bonds which no man can sever. Many of the groups of insects are of considerable economic importance, and the speaker is of the opinion that he who will work out a synopsis of any such group is doing much to advance the science of economic entomology. We are to-day hampered by the fact that it is extremely difficult for the beginner to recognize injurious species, or for the one more advanced to determine many forms which may be brought to his notice on account of unusual

depredations. This difficulty can not be overcome till every group having any economic importance has been carefully treated in a systematic way, and if this account also includes a brief general discussion of the economic importance of the groups, subgroups, and possibly even genera and species, together with references to the more important literature treating of each, we have at our command a series of works which would be of the greatest value to all subsequent students of economic entomology. Such works as these would necessarily be very concise, and yet, if properly arranged and with well-selected references, would prove of utmost value not only to systematic, but to economic workers, and would also be exceedingly helpful to all having even a general interest in the groups treated. Dr. Lugger's reports are an approach to this ideal, but it seems to the speaker that such accounts might well be more detailed and should include, as nearly as possible, every species in the fauna; and that the value of such treatment would be immensely increased by the addition of bibliographic references as mentioned above.

Reference has been made to the close analytical study of our economic publications by Dr. Forbes, and the speaker can do no better than bring his remarks to a close by quoting this talented scientist, as follows:

It is not the wealth one gathers, but that which he puts to use, which makes him rich. It is not the knowledge we acquire, but what we succeed in making application of, which makes us wise. It is not the facts of entomology we discover, but those which we persuade the farmer, the gardener, or the fruit-grower to use diligently for the protection or the preservation of his crops, which make our entomology economic. To discover without publishing effectually is to waste our time as servants of the public. To publish valuable results without making sure of their appreciation and appropriation by our constituents, is to fail of real usefulness and the reward of usefulness. To bring a result to bear on the practice of one man only when a thousand are suffering for the want of it, is to fail in 99.9 per cent of our proper undertaking. We must first do exact, exhaustive, conclusive, practical economic work, and then we must find means to get that work utilized or it is an economic dead loss.

The address was listened to with much interest, and, on motion of Dr. Howard, a vote of thanks was tendered to Mr. Felt. The discussion of the address was postponed until the afternoon session, but is here inserted in connection with the address.

Mr. Washburn called attention to the fact that Mr. Felt had referred to some notes on Diptera, which he thought possibly were left in Professor Lugger's possession. A careful search for these notes had been made by Mr. Washburn, but none were found. A year had elapsed between Dr. Lugger's death and the time of his taking charge of the work in Minnesota, and during that period things were in a rather chaotic condition.

Mr. Banks remarked that he would like the members to express their opinion as to what they considered desirable in the way of indices. He stated that it was difficult to obtain all the references in newspapers, and thought that those published by agricultural weeklies were hardly worth the trouble of indexing.

Mr. Osborn stated that he thought this to be a very important part of entomological literature for the practical farmer and horticulturist. Many of these men do not get the publications from the experiment stations and they depend upon these agricultural articles. While it seemed a very thankless sort of task, he thought that an entomologist should be willing to attend to this feature of the work for the benefit of the class of persons mentioned. Mr. Osborn further remarked that he had sometimes found himself looking in a plant index for an insect's name, but had usually discovered his error in a very short time.

Mr. Felt spoke of the annoyance which he experienced in referring to separate indices, such as is found in the Entomologists' Monthly Magazine, which has a number of special indices; and, while he did not know the experience of other entomologists in regard to this point, in his own experience he had found the food-plant index invaluable.

Mr. Banks stated that at the present time a great many genera had been duplicated in botany and zoology, and it was sometimes difficult to tell whether a plant or an insect was referred to.

Mr. Felt replied that he thought the name of the plant in connection with the insect affecting it is very easily indicated and he thought there was very little reason for separating the plant and insect indices.

Mr. Hopkins stated that his experience had been similar to Mr. Felt's in looking up references. It is somewhat confusing to turn to two indices, and he thought the suggestion by the president was in harmony with progress in this line. In his opinion, the host-plant index should be included with the other, and he urged the importance of both the common and the scientific names of host plants in the index. The trouble suggested by Mr. Banks could be avoided by using common names. By using the most popular common name, followed by the scientific name, it would be at once apparent which species was referred to.

Mr. Hopkins further remarked that in reference to indexing newspaper articles it seemed a waste of time. If it is some well-known agricultural journal, like the Country Gentleman or some of those papers of which permanent files are kept and good indices made, it might be worth while; but many of our agricultural papers, as well as newspapers, have no index, and a file of the paper is not kept. He did not consider it of much use to refer to these, from the fact that the reference could not be looked up. Furthermore, most of these newspaper articles are simply summaries of what has already been published elsewhere.

Mr. Kotinsky thought that the only objection thus far made to the separation of the plant index from that of the insect index is that one constantly discovers himself looking in the wrong place. He thought that use might be made of Mr. Felt's suggestion of heading the respective pages with the words "plant index" or "insect index" as the case might be. He thought the plant index should be made particularly with reference to the idea of indicating the food plants of the insects and thought use should be made of Mr. Schwarz's suggestion of not making an index simply of names, but an index of information that would be found in the publications cited. If the plant index be used to indicate the food plants of insects and at the same time measures be taken to avoid confusing plant and insect names as Mr. Banks had found himself doing, he thought a considerable advance would have been made.

Mr. Felt remarked that in making an index the work should be considered not only from the standpoint of the specialist, who is looking perhaps for some particular record, but from the standpoint of all who may have occasion to use that index. Generally speaking, he was inclined to think that an entomologist would hardly use and incorporate the name of an insect in his report without accompanying it with some fact which would probably be useful to some person, and while Mr. Schwarz's criticism of indices of Dr. Lintner's report might be true, he did not think that it would apply in all cases. Mr. Felt stated that he had modified the method of making indices somewhat in later years, and had omitted indexing some matter which Mr. Schwarz would probably be very glad to have left out; and yet, as a matter of fact, he thought these minor references might have been of some service to others. Mr. Felt spoke further on a little device which he had used in his indices, namely, the inclusive reference. He considered it a serious mistake to index a name, say of the Hessian Fly, wherever it occurred in a publication without giving any idea whatever as to the character of the reference, particularly where there was a detailed account. He thought that if the inclusive reference was used, giving a little synopsis, a much more serviceable index was secured, and then it was easy to distinguish between extended notices and mere references.

Mr. Howard referred to the indices of the Proceedings of the Entomological Society of Washington, prepared by Mr. Schwarz, and considered them perfect models of short indices.

Mr. Banks queried whether recent nomenclature should be used in index work or the nomenclature well known to entomologists.

Mr. Felt remarked that he had considered incorporating something about this matter in his address, but thought it might prolong it unduly.

The report of the secretary and treasurer was read and referred to an auditing committee appointed by the Chair, as follows: Dr. Henry Skinner and Mr. E. A. Schwarz.

The following names were proposed for membership by Mr. Howard: August Busek, J. Kotinsky, Otto Heideman, R. P. Currie, H. G. Dyar, W. E. Hinds, G. H. Harris, H. G. Barber, H. E. Burke, and J. L. Webb. Mr. Quaintance proposed for active membership Messrs. R. I. Smith and T. B. Symons, of the Maryland Agricultural College. Professor Webster proposed for foreign membership the name of Mr. Joseph Jablonowski, of the Entomological Station, Budapest, Hungary.

Mr. Marlatt inquired if election was necessary in the case of those qualified by their official position.

Mr. Felt thought that according to the constitution it was not, and that the only question was should a committee determine whether their positions qualified them for membership.

On motion of Mr. Osborn, a committee consisting of Messrs. Osborn, Quaintance, and Banks was appointed by the chair to consider the names which had been presented for membership and any others that might be proposed during the sessions.

Mr. Marlatt moved that the chair appoint a programme committee to arrange a programme for succeeding meetings, which was duly carried. The chair named Messrs. Marlatt, Fernald, and Burgess.

Mr. Howard moved that a committee of three be appointed on resolutions, which was carried, and Messrs. Washburn, Busek, and Rumsey were named by the chair.

A paper was next presented by Mr. A. F. Burgess, as follows:

ECONOMIC NOTES ON THE FAMILY COCCINELLIDÆ.

By A. F. BURGESS, *Columbus, Ohio.*

Several years ago while located at Malden, Mass., I became interested in the study of the food habits of this family of beetles. Considerable data was collected at that time, and since some additional notes have been obtained; and it seems desirable to place the facts on record, as they may serve as an aid to some future investigator of this subject.

Many of these beetles hibernate during the winter in the adult stage. In Massachusetts it often happens that the most common ladybird, *Adalia bipunctata*, hibernates in dwellings, and sometimes appears during midwinter in rooms which are heated, usually to the disgust of the housewife, who, not recognizing the friendly character of her guest, immediately wages a war of extermination.

The following species have been captured on dates which indicate that they hibernate as adults:

Megilla maculata DeG.—Several hundred examples taken March 31, 1900, at Urbana, Ill. It is a common species in that locality.

Hippodamia glacialis Fab.—Taken at Malden, Mass., November 4, 1897.

Hippodamia parenthesis Say.—Taken at Malden, Mass., November 4, 1897. Taken at Urbana, Ill., April 5, 1900.

Coccinella trifasciata Linn.—Taken at Malden, Mass., April 13, 1898.

Coccinella 9-notata Hbst.—Taken at Malden, Mass., April 12, 1898.

Coccinella sanguinea Linn.—Taken at Malden, Mass., May 1, 1898. Taken at Urbana, Ill., April 15, 1900.

Adalia bipunctata Linn.—The most common species in eastern Massachusetts occurs under loose bark of trees and in sheltered places during the winter.

Harmonia picta Rand.—Taken at Malden, Mass., May 1, 1898.

Mysia pullata Say.—Taken at Malden, Mass., May 2, 1898.

Anatis 15-punctata Oliv.—Taken at Malden, Mass., January 12 and April 10, 1898.

Chilocorus bifulvus Muls.—Taken at Malden, Mass., April 13, 1898. Taken at Urbana, Ill., April 26, 1900.

Pentilia misella Lec.—Taken at Lakeside, Ohio, October 27, 1900. Large colonies were found under cloth bands, which had been tied around the trunks of plum trees infested with San Jose scale. There were thousands of beetles in this orchard.

Brachyacantha ursina Fab.—Taken at Malden, Mass., May 5, 1898.

Hyperaspis signata Oliv.—Taken at Malden, Mass., May 1, 1898.

Of the 14 species above listed, *Megilla maculata* and *Adalia bipunctata* were the only ones which were found during the winter in colonies. In most cases isolated beetles remain during the winter under the loose bark of trees or under leaves or rubbish, and come forth on the first warm days in spring to search for food.

Early in the spring of 1898 they were first found feeding upon plant-lice eggs. These eggs do not hatch until several days after the beetles appear; hence this habit of the beetles serves to reduce the number of lice considerably.

April 13, 1898, many specimens of *Adalia bipunctata* were found feeding on the eggs of an aphid, which was particularly abundant on the white birch at Malden. A few days later *Anatis 15-punctata*, *Coccinella sanguinea*, *C. 9-notata*, and *Chilocorus bifulvus*, as well as *Adalia bipunctata* and its variety, *humeralis*, were found busily engaged in feeding on the aphid eggs. Thousands of specimens of *Adalia* were present, and large numbers of *Anatis*, the other species occurring in moderate quantities. Three days later both *Adalia* and *Anatis* were found mating, and an egg-cluster of the former species was also discovered.

The aphid eggs were found hatching April 18, the young lice at once proceeding to the leaf buds, which were just beginning to burst open. The development of foliage was considerably retarded by the cold and wet weather which characterized the spring of 1898.

Larvæ of *Adalia* were found May 1. At this time an excellent opportunity was offered to observe the interrelations between several

species of insects. The ladybirds in both adult and larval stages fed greedily on the eggs of the plant-lice and the young lice as soon as they hatched. Accompanying the beetles was also noted several species of predaceous bugs, the most common one being *Podisus sericeiventris*. Although this species was occasionally found feeding on the plant-lice, it was continually observed preying upon the ladybirds in all their stages. The particular species upon which it was taken in the act of feeding were *Adalia bipunctata* in the egg, larval, and adult stages; *Coccinella trifasciata*, and *Chilocorus birulnerus*. Four specimens of *Podisus sericeiventris* were once observed feeding on a single adult *Adalia bipunctata*.

It is a well-known fact that many species of insects will become cannibals if kept in confinement with insufficient food, but *Adalia bipunctata* has been observed repeatedly in the woods feeding upon the eggs of its own species when plenty of other food was available and within easy reach.

By the last part of July scarcely a plant-louse or a ladybird could be found in the locality where they had both been so abundant.

Several species of Coccinellidae were bred in confinement, and the following table gives their egg-laying records. A pair of beetles was placed in each jar with food, and the record was continued until the female died:

Egg-laying records of several species of ladybirds.

[The asterisk (*) indicates the date on which the experiment was begun.]

Date.	<i>Adalia bipunctata</i> .	<i>A. bipunctata</i> , var. <i>humeralis</i> .	<i>Anatis 15-punctata</i> .	<i>Coccinella</i> <i>san-</i> <i>guinea</i> .	<i>Coccinella</i> <i>9-</i> <i>notata</i> .	<i>Coccinella</i> <i>tri-</i> <i>fasciata</i> .
April 6	*					
8		*				
11		29				
13		15	*			
17		29				*
18	9	27				
19		9				
20		11				
22			13			
23		2	20			
24	8					
28			9			
May 1	13		9	*		
6				*	12	
8				14	17	7
9		15		6	12	
10						*
11		12				
12		13		12	9	
13		20	6	20	5	24
14				17		12
16		6				
18		21		26	4	20
19	11	18		27	1	9
20			14	1	10	
21		8		5		18
22		2		8		
23		1				12
24		7	*			
27		10				
28		19				
29						
30			23		3	
June 2			33			

Egg-laying records of several species of ladybirds—Continued.

Date.	<i>Adalia bipunctata.</i>		<i>A. bipunctata,</i> <i>var. humeralis.</i>		<i>Anatis 15-punctata.</i>		<i>Coccinella sanguinea.</i>	<i>Coccinella 9-notata.</i>	<i>Coccinella trifasciata.</i>		
June	3								28		
	4		16					15			
	7							23	15		
	8		12					21			
	9							60			
	10		6					38	16		
	11							39			
	12							15			
	13		13					20			
	14		20								
	15		20								
	16								18		
	17							2			
	19							20	12		
	21								16		
	22								20		
	24		13								
	26								25		
	27								10		
	28		20								
July	1								15		
	6								19		
	8								15		
	13								18		
	14								9		
	15								5		
	26								12		
	27								15		
	28								20		
	30								19		
	31								23		
Aug.	6								2		
	7								7		
	9								4		
		30	122	145	205	71	136	73	19	251	426

A pair of *Adalia bipunctata* var. *humeralis* (see column 3) was placed in a jar with food April 13, and eggs were deposited on April 20 and 23. On May 3 the female was isolated, but continued to deposit eggs for three weeks. The eggs, 105 in number, laid from that date until May 20, hatched, but 18 laid subsequent to the 20th did not hatch. In this case the female continued to lay fertile eggs for sixteen days after being isolated.

Several species of ladybirds were reared, and the number of days spent in each stage is given below. In cases where more than one individual of a species was reared the average number of days spent in each stage is given in the table.

Number of days spent in different stages of development by several species of ladybirds.

Species.	Egg.	First larval.	Second larval.	Third larval.	Fourth larval.	Pupa.	Adult to adult.
<i>Adalia bipunctata</i>	6	6	5	5	7	9	38
<i>Adalia bipunctata</i> var. <i>humeralis</i> ..	5	6	5	6	7	9	38
<i>Anatis</i> 15-punctata.....	8	6	6	5	12	9	46
<i>Chilocorus bivulnerus</i>	13					8	
<i>Mysia pullata</i>	7	10	5	9	14	7	52
<i>Coccinella sanguinea</i>	7	5	6	5	7	7	36
<i>Coccinella</i> 9-notata.....	7	6	4	2	6	6	30
<i>Coccinella</i> trifasciata.....	5	5	6	4	6	8	36

I did not succeed in rearing *Chilocorus bivulnerus*, but secured only the data given in the table.

The length of time spent by these beetles in their different stages varies considerably; it is influenced chiefly by the food supply and weather conditions.

If they are furnished with an abundance of food, and the weather is very warm, the length of time spent in each stage may be considerably reduced.

The next table gives a somewhat incomplete record of the average amount of food consumed daily by the beetles and the amount eaten during each larval stage while they were being reared in captivity. The aphids which served as food were of different species, and would average about the size of half-grown apple aphids. The birch aphid eggs were of the same form and color, but slightly smaller than the eggs of the apple aphid.

Number of aphids consumed daily by ladybirds of several species during different stages.

Species.	First larval stage.	Second larval stage.	Third larval stage.	Fourth larval stage.	Adult stage.
<i>Adalia bipunctata</i>	6	7	23	10	10
<i>Anatis 15-punctata</i>	51	55	107	213	90
<i>Mysia pullata</i>					50
<i>Coccinella sanguinea</i>	10	55	60		
<i>Coccinella 9-notata</i>	23	36			100
<i>Coccinella trifasciata</i>	10	30	50	155	50

An adult specimen of *Adalia bipunctata* consumed 100 aphid eggs daily, and an adult of *Chilocorus bivulnerus* ate about one-half as many of these eggs during the same period.

The records given show in a general way something of the economic value of the insects discussed, and gives, it is hoped, more definite data concerning some points in their life history than has been published heretofore.

Mr. Marlatt stated that he had been much interested in this paper, and thought that it threw light on a number of matters about which information was needed. He asked Mr. Kotinsky to give a brief statement on the amount of food which the Asiatic ladybird would eat, since Mr. Kotinsky had been looking after those details. He further stated that the egg records which Mr. Burgess had given were interesting, but he did not consider them of sufficient number to warrant definite conclusions as to the number of eggs deposited by the insects. He thought Mr. Schwarz could give some information on that point. He thought that probably all ladybirds would be found to live for a considerable length of time, the imported *Chilocorus similis* sur-

viving nearly a year, and that egg laying normally extended over a protracted period.

Mr. Kotinsky stated that he had been charged by Mr. Marlatt with the care of the imported Asiatic ladybird ever since it had reached this country, a little over a year ago. He had had occasion to closely watch its food habits until during the summer, when large numbers were available and could safely be confined for close observation. At Mr. Marlatt's suggestion he had once placed three larvæ, one each of the first, second, and third stages, in a jar upon a peach twig covered with young newly hatched peach scales (*Diaspis pentagona*). These had been kept for seventy-two hours, and after making very liberal allowance it was calculated that they had eaten in the course of those three days some 14,000 larvæ, an average rate of 1,500 in the course of twenty-four hours, or a little over one per minute for each beetle larva. Upon a closer observation still he had found that a half-grown larva about the second stage would eat a larva of the scale in the course of about five or six seconds, and would consume about 5 or 6 per minute. He thought the larvæ spent some time wandering about, resting, etc., which accounted for the reduced average when rates per day were considered. Only on one occasion, and that an abnormal one, had he observed one of the larvæ to eat another. This occurred when two full-grown larvæ were confined upon a stick which had no food upon it at all. He was rather surprised to find that the smaller of them had been eaten into by the large fellow immediately back of the head. The beetles themselves are equally voracious. He had not had a chance to count, but they will eat the scale in all stages and plenty of them. It is very interesting to watch them devour an old scale. They do not bore underneath it, but gnaw a hole through the scale close to the exuvium and presumably suck the juices of the scale insect. Time and again he had found the mutilated skin of the adult female adhering closely to the inside of a scale. Once in a while he had seen the beetles chasing each other and enjoying themselves generally upon the twigs. It was also very amusing to see a female sitting over a scale, the ovipositor projected underneath, and herself engaged, in many instances, in calmly devouring the host, which she had apparently withdrawn from beneath its dome. He had never found an egg beneath a scale when it was perforated. Normally the egg is deposited underneath the scale, but he had seen some deposited on the bark, but in no instance had he observed that under these conditions they hatched into larvæ. He had also found some eggs among the bristles of empty pupæ cases.

Mr. Kotinsky further remarked that he had been much interested in the note made by Mr. Burgess on the failure of breeding *Chilocorus bifulvius*. In spite of all his efforts for over a year now, he had failed absolutely in obtaining the eggs from this species. Mr. Heideman

had once called his attention to a tree on the grounds of the Department of Agriculture thickly covered with the Putnam scale (*Aspidiotus ancyllus*), upon which were feeding a number of the twice-stabbed ladybird larvæ. These were the first larvæ of this species which he had noted last summer, as they were unusually scarce. Repeated attempts to obtain the eggs from either the captured adults or other beetles reared in confinement had resulted in disappointment. He expressed a desire to compare eggs of this species with those of *Chilocorus similis*. He was not aware that the egg of any *Chilocorus* had been previously described, which accounted for the difficulty experienced in finding the eggs. There were only two beetles of the Japanese ladybird left in the spring, and the absorbing problem with him had been to find the eggs. Some one had suggested that these might be found in clusters on the surface of the bark, but this did not prove to be the case. He had frequently turned up the scales upon traversed twigs to see whether the scale insects were edible, and in the course of these examinations had discovered underneath the scale something which had at first been taken to be a parasite of the scale insect, but which upon closer examination proved to be the egg of *Chilocorus similis*.

Mr. Howard remarked that he was not aware of other careful observations upon the life history of Coccinellids in this country except the series of Mr. Marlatt and Mr. Kotinsky, and those made by Mr. Coquillet in California, and his recollection was that the total life from egg to adult of *Uedalia cardinalis* in California was much shorter than the life histories which Mr. Burgess had followed in Massachusetts.

Mr. Coquillet stated that his observations on those ladybirds in California had been so long ago that the details had passed from his mind.

Mr. Fiske stated in relation to the life history of *Chilocorus bicoloratus* in Georgia that he considered it a most valuable species from an economic standpoint, and that he had had a good many opportunities to observe its younger stages and to observe it throughout the year. The eggs had been for a long time unknown to him, but last spring he had found them in considerable quantities upon old peach trees infested with the cherry scale, and the eggs were situated under the scales on the bark. At the time they were found they were brown in color instead of yellow, as he had expected. They were not reared to full maturity. He mentioned a very interesting instance which had occurred in Georgia the present year indicating the value of ladybirds. The season had been very long and unusually dry and the plant-lice had had an unusually good opportunity for development; especially was this true of the cotton aphid. Although this insect usually disappears about the first or middle of June, it continued the present year up until the 1st of July and threatened to do considerable damage.

About the middle of July letters began to come in to the Department concerning a so-called new insect occurring on cotton. The prevalence of the Colorado potato beetle in Georgia at the present time led many of the cotton growers to think that this plant was being attacked by the Colorado potato beetle. Upon receiving specimens of the insect injuring cotton, it proved to be *Hippodamia convergens*, the specimens received being mostly in the larval and pupal conditions. For some time something over twenty letters a day were received from cotton growers concerning this insect. He had made two or three trips to the cotton fields to observe this species and found that it occurred in very extraordinary numbers; thousands of them on the cotton plants. There would be as many as a dozen or fifteen or even twenty larvæ and pupæ of this ladybird on one tip of the plant, perhaps no more than 3 inches long. There were also present larvæ of certain lace-winged flies, but he considered this ladybird beetle the principal agent in checking the outbreak of the cotton aphid.

Mr. Fiske further stated that both he and Mr. Scott had been giving considerable attention to the ladybirds as found in Georgia and hoped soon to be able to publish a paper on them. One species, an *Eucromis*, had been reported as feeding on scale insects, and he was informed, he thought by Mr. Schwarz, that this genus was one that fed almost exclusively on scale insects. He had observed this species frequently, and so far it had occurred largely on plant-lice and only occasionally on scale insects.

Mr. Burgess remarked in reference to *Chilocorus bifulvus* that he had attempted to rear it a number of times; but had been unable to do so. This species appeared to feed on plant-lice, and when plant-lice eggs were offered the beetles early in the spring they were devoured quite greedily. In his own experiments he had been able to obtain only two or three eggs of this species, and they had been deposited on a twig placed in a jar. Only one of these eggs had hatched, and this was how he had obtained the record indicated, of the length of the egg stage.

The next paper, presented by Mr. F. L. Washburn, was as follows:

DISTRIBUTION OF THE CHINCH BUG IN MINNESOTA.

By F. L. WASHBURN, *St. Anthony Park, Minn.*

From observations made last summer, from reports of correspondents, and from press articles it is evident that the chinch bug has been this season confined to the southeastern, south central, and southern portions of the State. Careful examination of Professor Lugger's past reports indicates that this is not a condition of affairs

peculiar to this year, but can be regarded as the permanent condition in Minnesota.

An imaginary line drawn from Mora, in the east central part of this State, southwest to Benson and then south to Iowa would include on its southern and eastern side the area infested this year. It is not to be understood that all of this territory was occupied by the chinch

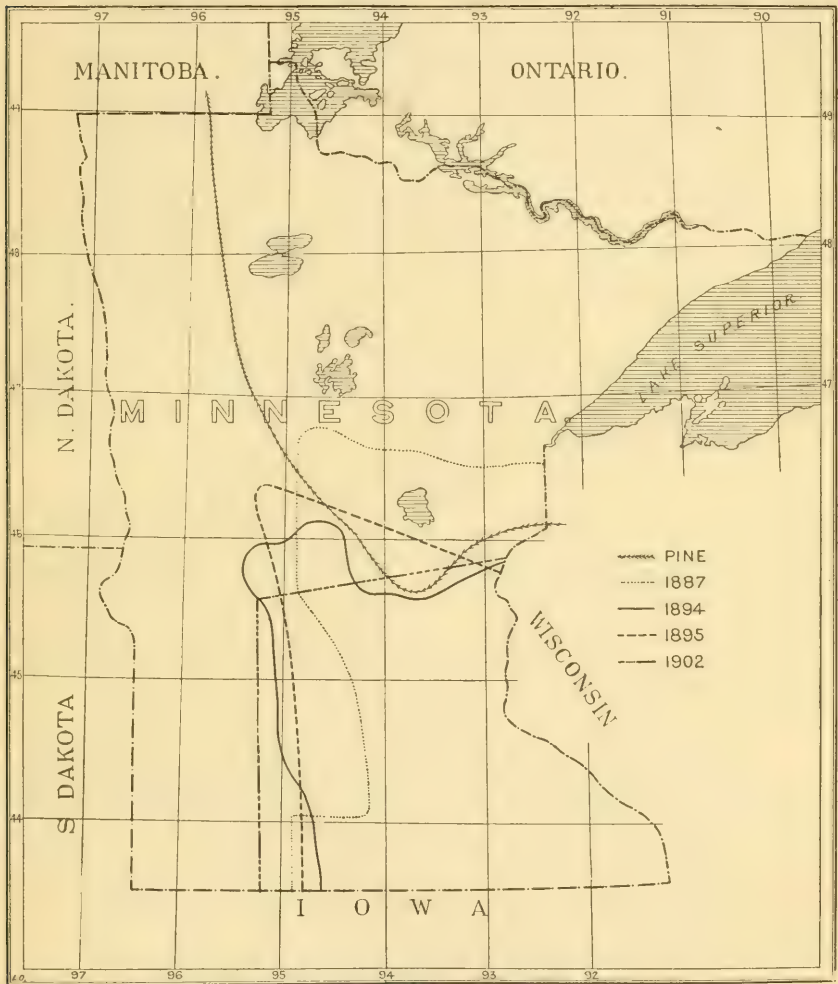


FIG. 1.—Map showing distribution of chinch bug in Minnesota.

bug, but all the infested counties heard from would be included by such a line. I note that Dr. Lugger's reports for 1887, 1894, and 1895 coincide quite closely with the conditions of 1902. To make this more clear I have had a map (fig. 1) copied from one of his reports, to which I have added the line I refer to as representing my findings this year. In the years noted (1887, 1894, and 1895) Dr. Lugger found the same

counties infested which I have reported upon and in addition, as you will note from the chart, a few counties to the north. He also refers to one isolated example in 1895 from the extreme northern part of the State near Lake Vermilion. This latter reference, as far as I can make out, is something in the nature of a rumor. I can find no specimens in the collection substantiating the report. The chinch bug is not known in the Red River Valley along the western border, nor is it known north of the imaginary line shown in the map, with the possible exception above noted. It occurred to me that these conditions might interest entomologists, particularly as maps have been published and republished indicating in a general way that the chinch bug is found over the entire State. It must be admitted that a few sections might have chinch bugs which are not reported; nevertheless the close similarity in the findings of the late Dr. Lugger and the present entomologist would seem to place the matter of its distribution beyond question. The year has been unfavorable for this pest, the summer having been a decidedly wet one. I might say that much of the blame of injury caused by the Hessian fly, a pest even now of almost universal occurrence in Minnesota, has this summer been laid at the door of the chinch bug, with which farmers are much more familiar than they are with the former insect.

At the conclusion of this paper Mr. Burgess inquired of Mr. Washburn if the chinch bug fungus was being used in Minnesota to any extent at the present time.

Mr. Washburn replied that it had been almost entirely abandoned. It had not been found practicable.

The meeting then adjourned, to reassemble at 2 p. m.

AFTERNOON SESSION, FRIDAY, DECEMBER 26, 1902, 2 P. M.

The meeting was called to order by the president, who, after calling Mr. Osborn to the chair, presented a paper on the following subject:

OBSERVATIONS ON THE GRAPEVINE ROOT-WORM.

By E. P. FELT, *Albany, N. Y.*

[Withdrawn for publication elsewhere.]

Mr. Burgess remarked that the life history of the grapevine root-worm had been worked out by Messrs. Webster and Mally several years ago, and that this had been published along with results of their experiments in its control. A year ago he had carried on a few experiments under Mr. Webster's direction for spraying for this insect with arsenate of lead, and, although the results were not con-

clusive, it appeared that some considerable benefit had been derived from the spraying. He stated that the grapevine root-worm occurred in the grape districts in northern Ohio, especially east of Cleveland, where in some localities it did a great deal of injury.

The next paper was presented by Mr. Osborn, as follows:

A METHOD FOR MOUNTING DRY COCCIDÆ FOR PERMANENT PRESERVATION.

By HERBERT OSBORN, *Columbus, Ohio.*

Probably all who have had occasion to preserve scale insects have appreciated the desirability of obtaining a more practicable method than those now in vogue. The writer has tried the several methods in use, such as pinning in insect boxes, inclosing the specimens in glass vials or tubes, placing them in folded papers, etc. Each has its own disadvantage, and one common to all is that of the danger of the scales being scraped off or loosening in time so they fall off.

The plan now proposed is to put the specimens, together with the twig or leaf to which they are attached, between two slips of mica which are the size of the standard 3 by 1 microscope slide, the two slips being bound together by pieces of gummed paper, as in mounting lantern slides. At one end a label may be placed. The whole fits into a microscope-slide box, and the mounts may thus be filed along with balsam mounts. The advantages to be gained by the method are: Preservation from moisture, from insect pests, and from ravages of other character. Not the least of the advantages are those of storing and facility of handling. Thus, the mounts may be filed, as described above, in slide boxes, or they may be pinned in insect boxes or placed under glass for exhibition purposes, and if desired they can be wrapped in bundles and carried in the pocket into the field. This latter suggestion may meet with sympathy from those field collectors or inspectors who desire to take with them into the field authentic specimens for reference.

The method of mounting may be varied for the different kinds of specimens. Thus, thin leaves may be simply pressed between the two sheets of mica and the edges bound. For pieces of bark and thicker leaves or rind of fruits a cell about three-fourths of an inch by 2 inches may be made from cardboard, in which the specimens may be placed, the mica slips being bound over the cell. For still thicker pieces, such as small twigs, the cell may be made deeper while the ends of the mount are left thin in order to fit into the grooves in the slide boxes.

The specimens to be mounted should be thoroughly dry. In the case of leaves, pieces of bark, orange rind, or parts that tend to curl,

in order that they may lie to the best advantage they should be dried, as in the preparation of botanical specimens, between blotters. If desired, glass slides may be used and mica used for covering. The advantage of mica over glass is evident, as the mica is not subject to breaking as readily as glass and is much lighter.

The expense for material is but little more than 1 cent per mount, and the mounts can be made in very short time by anyone neat at pasting, so the cost of the method is certainly within reason.

The next paper was presented by Mr. Felt, and was on the following subject:

RESULTS OBTAINED WITH CERTAIN INSECTICIDES.

By E. P. FELT, *Albany N. Y.*

[Withdrawn for publication elsewhere.]

At the conclusion of this paper it was voted to defer discussion until a series of papers of a similar character had been presented.

The next paper was presented by Mr. Quaintance.

FURTHER NOTES ON THE LIME, SULPHUR, AND SALT WASH IN MARYLAND.

By A. L. QUAINANCE, *College Park, Md.*

At the Pittsburg meeting in June last I presented some notes on the use of the lime, sulphur, and salt wash as a treatment for the San Jose scale in Maryland. Further observations have been made on these tests, and it appears desirable to briefly present the results, particularly since the conclusions reached in June as to the lack of efficiency of the wash now appear to have been premature.

Experiment I.—Twenty badly infested Japan plum trees were treated at College Park, Md., on March 4. The last examination before the Pittsburg meeting was made on June 2, practically three months later. At this time the young live scales were very numerous, crawling around over the limbs and branches, and many had already settled. Live adult females were also very abundant even where the wash was still adhering to the trees. Scraping infested branches with a knife blade flatwise pressed out an abundance of the oily fluid from the

bodies of the insects. The per cent of scale killed by the treatment was carefully estimated at from 55 to 60.

Examinations of these trees at different times during July and August revealed that the scales were gradually becoming less and less instead of more numerous, as would have been expected from the large per cent of adult insects that had escaped treatment. By the first week in July the over-wintering females were practically all dead, having given birth to their young. The young larvæ to a considerable extent failed to permanently establish themselves, and practically all of those which had settled soon afterwards died. Only here and there could a live maturing insect be found, and these were mostly on the terminal growth. By the middle of August the old scales were peeling from the trunks and branches, and on September 6, the date of last examination, the trees were noticeably brighter and smoother, owing to the general falling off of the dead scales. But comparatively few live scales could be found, although these same trees were alive with the crawling larvæ in June.

Experiment II.—This test was made at Annapolis Junction on 225 10-year-old apple trees and about 50 2-year-old peach trees. The wash was applied March 27 and 28. An examination on June 13, about two and one-half months later, showed young, crawling lice in great abundance, and the mature breeding females were so numerous that but little good appeared to have been accomplished by the treatment. The percentage of scales killed was placed at from 45 to 50.

This orchard was not examined again until September 8. Instead of finding these trees badly infested with scale they were found to be remarkably clean. Live scales were really hard to find even this late in the season. The old scales had largely shelled off and the trunks and limbs had taken on a slick, healthy appearance. Even on trees that had been encrusted with scales the results were apparently equally good.

The final outcome of these tests of the wash was quite a surprise. It would appear that results have been expected too soon after the application of the wash, and it further appears, as has recently been shown by Mally^a in the case of *Diaspis pentagona*, that a sufficient amount of the wash probably remains on the trunks and limbs to destroy the larvæ coming from those females which escaped the treatment. The final effect of the wash in the two cases cited and in other cases that have come under my observation leads me to believe that we have a most valuable treatment for the San Jose scale in the lime, sulphur, and salt wash.

^aEntomological News, vol. 13, p. 223.

Following this paper the secretary read a communication from Mr. W. E. Britton, as follows:

THE LIME, SULPHUR, AND SALT MIXTURE IN CONNECTICUT.

By W. E. BRITTON, *New Haven, Conn.*

In the spraying experiments conducted by the station during the spring of 1902 the lime, sulphur, and salt mixture was given a trial in three different localities in Connecticut. April 1 a pear tree near New Haven was sprayed with a mixture containing 50 pounds of lime, 50 pounds of sulphur, and 50 pounds of salt to 150 gallons of water. Another pear tree was sprayed on April 15 with a mixture made in the same way. On May 23 a careful examination of these trees showed that less than 1 per cent of the scales were alive. The same formula was used on one peach tree and one cherry tree at Bridgeport April 16. No living insects could be found on these trees when examined on June 23. The trees were very late about putting out their leaves, and on April 18 six Japanese plum trees and one peach tree at Terryville were sprayed with a mixture made of 30 pounds of lime, 20 pounds of sulphur, 15 pounds of salt, and 60 gallons of water. On June 24 the trees were examined and the percentages of living insects were found to vary from 0 to 7, the average of the seven trees being 3.36 per cent. In each case this insecticide was used in comparison with 25 per cent crude oil mixed with water and several other mixtures. It proved to be as effective in destroying the scale insect as any of the other preparations employed, and in no case did it injure the trees, while some harm followed the application of crude oil, both undiluted and in the 25 per cent mixture, in several cases. The largest percentage of living insects on the sprayed trees occurred on branches which were very badly infested, being covered several layers in depth with the bodies of the insects. The insecticide in some cases had not penetrated the mass sufficiently to kill those at the bottom.

The lime, sulphur, and salt mixture has also been used in several large Connecticut orchards the past season, and has given satisfactory results. It will be employed much more extensively the coming season.

At the conclusion of this paper the subject was opened for discussion.

Mr. Alwood remarked that for some years he had been somewhat of an advocate of both refined and crude oil. In Virginia they had sprayed thousands of trees with these forms of petroleum, and in the main good results had followed. In some cases the results had been remarkably good. He desired to call attention to a case where the use of oils had been very beneficial. This particular case was a young

orchard of about 500 winesap apples. Scale insects were discovered on these trees, he thought in 1898, about three years after setting. The insects were discovered in the summer, and five trees out of the 500 or more were quite badly coated. There had been, of course, some spread to other trees. The young orchard was in a very beautiful condition, and the owner had appealed to him to do something to stop the spread of the insects. He had already been making experiments in the way of summer work, and so he recommended spraying these trees with pure kerosene, 150° flash test, and this had been done. Three of the trees had died from the treatment. They were covered with the scale, and of course were weak from the effect of the insect. Two of them had lived through the application of pure kerosene in the summer and are still living, and up to the present time were free from scale. He further stated that he had applied kerosene to some thousands of trees in the summer time, and in no case had trees been killed by its use except where he had killed them purposely in order to determine how much oil the trees could stand.

In the case of the young orchard cited, the insects had not all been exterminated and the oil was again applied in the dormant season, and this was repeated in 1900. In 1901 the application had been changed to crude petroleum late in the winter season or early in the spring. The scale was not eradicated by this treatment, and crude petroleum was used again in 1902. He thought the last application had largely eradicated the scale; but he had visited the orchard the 1st of September, 1902, and had found a very few San Jose scale on five trees. The infestation was chiefly at the base of the trees in the region where the trunks of the trees and soil come together. Some few had been found in crevices of the bark. He explained that this instance was mentioned because that orchard to-day is a remarkably fine one, 8 years old, apparently uninjured by the treatment, and the scale, while not eradicated, has been so thoroughly repressed that it had accomplished no harm. The trees that were first so thoroughly treated with the pure kerosene are apparently free from the scale. There are a few trees in the orchard which were never badly infested, probably six or eight, which are still slightly infested. This is only one of a good many cases in Virginia which could be mentioned, but was to be considered illustrative of the work where intelligently done.

Mr. Fiske stated that in Georgia the San Jose scale had been the chief feature of the work of the department of entomology for a good many years past. They had been obliged to fight it with every known means, and for some years oil had been recommended. In a way the oil treatment had been successful where applied correctly. Still there had been a good deal of complaint from growers that peach trees had been killed by the oil and that the fruit buds had been injured. He had found in comparing the published results with oil in the different parts of the country that a considerable difference of opinion prevails

as to its value. Last winter, in order to straighten out certain vexed points, a series of experiments had been instituted by the department. Several different orchards had been used, embracing trees in different stages of growth and in different conditions. These had been sprayed with oil, with the lime, sulphur, and salt wash, and various other mixtures. A few points had been cleared up, but the results of these experiments had raised numerous other points, so that on the whole, from his standpoint, he had not been much enlightened by the tests. In Georgia at the present time the question is not what is the best general treatment for the San Jose scale, but what is the best treatment for any particular orchard, and the conditions in every orchard are different. In the experiment work last winter two orchards had been used, one of which was two years old, containing large trees for their age, healthy and thoroughly infested with the scale. The other was an orchard of 4-year-old trees, healthy, rather mature, and, if anything, worse infested with scale than those of the younger orchard. The experiments were duplicated on these two orchards, which were situated about half a mile apart, the soil and weather conditions being practically the same. Frequently the same insecticide had been applied to the respective orchards on the same date and by the same hands. A treatment that had been perfectly successful in the older orchard was anything but successful on the young trees. For instance, 20 per cent petroleum in one application on the older trees was very effective in killing the scale, and in August and September there were practically no scales to be found on those trees. In the younger orchard, however, while it killed probably as many of the scale, yet, owing to the healthful condition of those trees, every young scale that hatched and settled down seemed to be successful and in due time gave birth to young. Thus in the fall in this orchard there were trees practically dead with the scale where hardly a live scale could be found in the spring. In the younger orchard there were half a dozen different varieties of peaches. On some varieties the scale was killed and in August they were practically free, while, with the same treatment in every respect, other varieties were badly infested with the scale. There were fully ten times as much scale on some varieties as on others. He considered it important in treating the San Jose scale to get first of all a knowledge of the condition of the tree as affecting the health of the scale. He considered it necessary to know, when advice was asked concerning treatment for any given orchard, what the condition of the orchard was. He considered that perhaps 20 per cent oil would be satisfactory or not, depending on the age and condition of the trees. In his opinion this was one reason why the results with oil had varied so much.

The present winter the lime, sulphur, and salt wash had been recommended largely, although with certain reservations, and he wanted to know if any who had experimented with it had found it unsatisfactory.

Mr. Alwood desired that those who had used the lime, sulphur, and salt wash would make their experience known, because he considered it a very important question. He stated that he had not used the wash enough to have come to definite conclusions about it. He considered that it was very important to discover a treatment that would not prove injurious to trees, for in his opinion the average workman would often be likely to injure trees by the oil treatment.

Mr. Fiske remarked that in connection with their experience with the wash as used last winter, the results were very much like those already reported by Mr. Quaintance. The scale had not been killed at once, and notes made in May as to the efficiency of the wash indicated that it was very unsatisfactory. It was estimated that from 10 to 25 per cent of the scales were alive on the trees at that time. Examinations in August, however, showed that the per cent of live scales was very much less. He did not think that the insects which actually escaped treatment bred so fast on trees sprayed with the lime, sulphur, and salt mixture as in the case of those sprayed with oil.

Mr. Burgess stated that a great deal of spraying had been done last winter in Ohio with crude petroleum, especially in the peach district, and a great deal of damage had been done. As a rule, crude petroleum had been used undiluted. He considered that if a grower uses a pump designed to make the mechanical mixture of the oil with water and sprays liberally, he may get as much oil on the tree as if he sprayed sparingly with the undiluted crude oil. A good many of the growers—a majority of them, in fact—used the pure crude oil. A large number of trees had been killed and a large number had been seriously injured. These were mostly peach. He did not recall at that time that apple trees had been seriously hurt by the use of pure crude petroleum, although a number of orchards had been treated with this substance, and the owners were of the opinion that the scale had been greatly reduced.

In reference to the lime, sulphur, and salt wash, Mr. Burgess stated that a few experiments had been made and a few growers had used the mixture, and, from what he had seen, the results were good. Some of the growers from northern Ohio had, within the last month, visited some of the peach and apple orchards in southern Illinois that had been treated by the spraying force employed by Dr. Forbes. These orchards had been treated the past winter with the lime, sulphur, and salt wash, and had been visited by the growers in order to get an idea of what could be done with this wash. They appeared to be very well satisfied with the treatment, and some were making arrangements to use it on their trees. Mr. Burgess further stated that in the peach district of northern Ohio he did not consider it advisable to recommend the use of crude oil in any form except to those growers who had been able to handle it successfully in the past. While some had

been able to spray their orchards with this substance without injury, many others had not. The reason for this difference was not plain to him, as in some cases, at least, there was reason to believe that the men were equally careful.

Mr. Webb stated that the results from spraying with the lime, sulphur, and salt wash had varied widely in Delaware. In some cases the results had been excellent. Five hundred 3-year-old trees in fair condition, only moderately infested with the scale, had been thoroughly sprayed with this wash, so that they were white from top to bottom. Shortly afterwards the trees had been examined very carefully by Professor Sanderson, who thought that not 25 per cent of the insects had been killed; but in August and September there were but very few living scales to be found. Mr. Webb stated that he had examined the apple trees frequently himself, and was very soon struck with the fact that no young scales could be found. On the other hand, an orchard on the adjoining farm, a year or two older, sprayed by the same men and under apparently similar conditions, showed very poor results. At no time during the season were the trees at all free from the young, crawling scales, and by the middle of the summer a great many of the trees had been ruined. On the whole, very little benefit seems to have come from the treatment. Mr. Webb thought there was undoubtedly an explanation of the difference in results, but was not able to account for the difference himself. Mr. Webb mentioned other cases where orchards of from 500 to 1,200 trees had been sprayed, though the work had not been done very thoroughly, but he considered the results excellent in view of the fact that the work had been done so poorly. Considerable crude oil and some refined oil had been used in Delaware on peaches and plums as well as on apples and pears, and there had been absolutely no injury, unless, as mentioned by Mr. Alwood, the attempt had been made to kill the trees. With some pumps, making a mechanical mixture of oil and water, the mixing had not been well done, some trees showing just a trace of oil and others were covered with a thick coat. Yet no injury had resulted from such treatment, so that the majority of fruit growers are rather inclined to use the oil.

Good results had also been secured by the use of the soap emulsion, which was used to a considerable extent, and, all things considered, he thought probably this had given best results. The refined kerosene had been used almost exclusively in making this soap emulsion, but very little of the crude oil being used. In one instance, where 25 per cent emulsion had been sprayed on plum trees just before the buds had opened, there had been no injury, and a full crop of fruit had been borne by the trees the following year. This same orchard had been treated in the spring of 1902 with approximately 33 per cent of kerosene emulsion with very excellent results, although the treatment

had been given somewhat earlier than that of the year previous. In another case an orchard of 3,000 trees had been sprayed with 20 and 25 per cent kerosene-soap emulsion, using two or three times as much soap as is ordinarily prescribed, also using Good's potash whale-oil soap. This treatment had been given during the spring of 1903 and up to November, but very few live scales were to be found in the orchard. It required very careful examinations to find any scales at all on approximately 90 per cent of the trees.

Mr. Alwood desired to know exactly how the emulsion had been prepared.

Mr. Webb stated that he had not done the work himself, simply observing it, but it was his recollection that a pound of soap was used to a gallon of water and a gallon of oil to make the emulsion, and then 2 gallons of water were added to make the 25 per cent mixture, and in other cases 3 gallons of water to make the 20 per cent mixture.

Mr. Fiske stated, in reference to the emulsion, that it had been used to some extent in Georgia last winter. It had been experimented with quite extensively, and the present winter a large number of growers were discarding their kerowater pumps and making the emulsion. They are putting it on at the rate of 16 per cent, and in general their method of procedure is to make an emulsion of 2 pounds of soap.

Mr. Fernald remarked that the San Jose scale had been in Massachusetts for some years, but that there had not been an opportunity for experimenting upon it until the present year. Last year and the year before the college orchard had been found to be quite badly infested. This orchard consists of 600 trees, ranging from 6 to 30 years old, and the infestation by the scale was very general. The idea in undertaking the tests was to determine the value of the different substances employed under New England conditions. Different trees were treated, the applications being made last spring, about March 27 to April 14. At that time the weather was quite variable, so that there was an opportunity to test the effect of different kinds of weather upon spraying operations. In view of the fact that it had been suggested that temperature and weather conditions in general might affect the results from spraying, full meteorological records were kept for every tree. This included a record of the temperature, force and direction of the wind, humidity, etc. A careful study of the records indicates that no relation exists, except possibly in a slight degree in the application of kerosene. Mr. Fernald did not consider that the weather made any perceptible difference, except as stated. As to the best method of determining results, the speaker stated that he soon became satisfied that early counting of the percentage of living scale was one that could not be depended on, from the fact that at that time of the year so many of the young scales are killed by the weather. Inspec-

tions were made every week over the whole orchard, and were continued until stopped by snow. Inspections were entirely in reference to the abundance of living scale as compared with the original inspection. The trees have been classified according to the results. Results were given as follows: Good's potash whale-oil soap No. 3, 2 pounds to the gallon of water, was sprayed thoroughly over all kinds of trees, including cherry, pear, apple, peach, plum, apricot, and nectarine. An examination showed that 28.12 per cent have been freed from the scale; the remaining 72 per cent are still infested. With the crude oil one or two additional facts should be mentioned. In regard to the unreliability of kerosene pumps, Mr. Fernald said that the one used by him had recently been in the hands of the manufacturers, who said that it was all right. Nevertheless, this pump often varied 20 per cent within five minutes. Of the trees treated with crude oil 40 per cent were freed from the scale, but many badly infested trees still remain. Mr. Fernald questioned if entomologists could afford to recommend to the fruit grower a pump which is likely to be as unreliable as was the pump used in his experiments. Twenty per cent kerosene put on in the same way gave a percentage of 44.44 of trees entirely freed from the scale. Bowker's tree soap gave 52.68 per cent freedom from scale, over half of the trees treated being cleared from the pest. Bowker's soda whale-oil soap gave 40.44 per cent freed from scale. Good's soap, 1 part, and lime, sulphur, and salt wash, 9 parts, was tried and gave only 28.8 per cent of freed trees. Lime, sulphur, and salt wash cleared 66 per cent of all the trees to which it was applied, and part of it was applied one evening just previous to a rain. This application had been made on March 29 and was still perceptible on the trees on June 10.

The conclusions reached by the speaker were that the lime, sulphur, and salt wash is the best treatment for the average man to use who has not had experience in spraying. Although the wash is hard to make and disagreeable to apply, the speaker nevertheless thought that in view of its low cost and the safety with which it might be applied, and, further, on account of its apparently continuous action, extending clear into the summer, that this wash would more nearly meet conditions in New England than anything else tried. Mr. Fernald considered it desirable that investigations should be made in reference to the preparation of the wash to simplify this process as much as possible.

Mr. Marlatt remarked that one interesting feature of the last two years is that after a lot of experimentation we are coming to the methods which have been followed in California for many years, namely, the use of the lime, sulphur, and salt wash and kerosene emulsion.

Mr. Fiske desired to know if anyone present knew anything about the Texas crude oil. He stated that it was now very cheap in the

South, and that many were asking if the Texas crude oil could be used in place of the Pennsylvania crude oil. He had used the Texas crude oil last summer as a summer treatment, with no injurious effect.

Mr. Caudell remarked that he had used the Texas crude oil while in Texas to keep ants from his insect collection. He understood that one defect was that it was of a very sticky nature, and if used on plants was likely to fill up the pores, thus suffocating them.

Mr. Marlatt stated in connection with the lime, sulphur, and salt wash that in his opinion a considerable part of the lime commonly used might just as well be left out. He thought that the use of kerosene emulsion would become more general from the fact that it was possible to secure a definite strength, no matter how the pump might work. He stated that there was some difficulty in preparing it, but if made as in California the work was greatly simplified. It is made up and put on the market, so that anyone desiring it in small quantities can secure it at no great advance in price.

Mr. Harris stated that he had used "Corsicana" oil in certain experiments against the cotton-boll weevil in Texas, and it was his experience that it had killed the plants.

The next paper was presented by Mr. Felt, and was on the following subject:

NOTES ON INJURIOUS INSECTS.

By E. P. FELT, *Albany, N. Y.*

[Withdrawn for publication elsewhere.]

The discussion of this paper was deferred until several of a similar character had been presented.

Mr. Osborn then presented the following paper:

INSECTS OF THE SEASON IN OHIO.

By HERBERT OSBORN, *Columbus, Ohio.*

In a previous paper I have noted some of the insect occurrences of the early part of the season; and as there has been no very excessive abundance of any pest during the latter part of the year, a rather brief review will suffice to put on record such as have attracted attention.

Grapevines have suffered quite severely from attacks of the leaf-hoppers (*Typhlocyba* spp.), in some cases the vines showing a decided wilting and the crop being evidently materially checked in growth. Leaf-hoppers, too, have been quite troublesome on roses and noted on many other plants. They are possibly only in about the average abundance.

Grasshoppers have been plentiful, *Melanoplus differentialis* being especially abundant in some localities, though I am not aware that it has occasioned any unusual concern on the part of farmers. Chinch bugs have been plentiful enough to be met with frequently in collecting, but I have not learned of any extensive injuries except in one or two instances in the early summer. Heavy rains and wet weather in July probably served to check them. The Hessian fly has not been attracting much attention, and there is apparently not much to fear from it for the coming crop. The wheat-stem maggot (*Meromyza americana*) was found in wheat fields near Sandusky, but only occasional stems were infested, and the loss from this species would not average more than 1 to 3 per cent in the fields examined.

Chionaspis corni Cooley was found in a clump of *Cornus asperifolia* about 3 miles from Sandusky in such quantities that several of the shrubs were nearly dead and others so severely infested that they must very likely succumb by another season. Were the dogwood planted to any extent as an ornamental shrub, this might readily become a serious pest.

An occurrence of the cigarette beetle (*Lasioderma serricornis*) was brought to my attention by one of the furniture firms of the city, who reported the damage of certain plush upholstered furniture and desired information as to the insect and especially in reference to the probability of its having gained entrance to the articles while in their possession. An examination of the furniture showed the plush covering to be penetrated at points and the insect to occur in considerable numbers in the cotton immediately beneath the plush and in many cases fragments of the plush covering mingled with the cotton. Underneath the cotton, in the filling, no specimens were observed. This evidence seems to show conclusively that the insect had entered after the covering had been put in place and was not due to the presence of the beetles or their eggs or their larvæ in the material used for filling. It seems that the furniture had been sent to this firm for re-covering; kept in their shops but a few days and returned to the owner, and that the injury had not been discovered until some eighteen months after being in the shops. In the meantime the house had been closed and unused for a period of some six weeks. The conclusion seems evident that the attack originated in an infestation occurring very likely during the time that the house remained unused, the beetles possibly gaining access by means of cigarette packages or some infested articles of furniture, and the fact that the articles were unused permitted the insect to become fairly well established. The firm in question are to be commended for their attitude in the matter, as they were anxious to make good any injury that could be traced to their own factories or to negligence on their part. The fact that no other furniture in their establishment has shown injury from this insect, along with the fact

that the furniture was in their possession for so short a time, makes it very certain that the infection was not due to their rooms or factory being infested. Specimens have been received from Prof. J. C. Hambleton, who found them at West Jefferson.

Chrysanthemums in Columbus were very seriously infested with plant-lice (*Nectarophora* sp.), apparently undescribed. They were first observed in a greenhouse in the early fall clustered on stems and leaves, and later they were found invading buds and blossoms to such an extent as to disfigure them very seriously. The manager of the greenhouse used tobacco-stem fumigation, but he did not succeed in more than giving a temporary check to the species.

The beech blight (*Schizoncura imbricata*) was quite abundant, producing the usual whitened appearance of the beeches.

It may be worth while here also to put on record the occurrence of the white ant (*Termes flavipes*) in the vicinity of Sandusky. Specimens were found there by Mr. O. A. Swezy. The species is abundant in central Ohio, but I have not met with it so far north before.

The fall canker-worm has been quite abundant and depositing numerous clusters of eggs, so there is every probability of a continuation of the ravages of this pest another year.

The following paper was presented by Mr. Quaintance:

ENTOMOLOGICAL NOTES FROM MARYLAND.

By A. L. QUAINANCE, *College Park, Md.*

The most noteworthy entomological fact even in Maryland the present year has been the occurrence of the periodical cicada. About the last of May 500 return postals were sent out to correspondents in various parts of the State to determine as accurately as possible the distribution of the insect. By means of replies from correspondents, and by personal observation, the distribution of the cicada has been fairly well determined for Maryland. The accompanying map will indicate the occurrence of Brood X in Maryland for 1902.

Considerable injury was occasioned by the cicadas, particularly in the more heavily wooded and the mountainous sections of the State. Young orchards of both peach and apple were in many instances so seriously punctured that prompt and severe pruning appeared necessary to save the trees. The current fruit crop in several peach orchards was quite destroyed. The cicada made its appearance, on the whole, from about the middle of May to the 1st of June, and had largely disappeared by the first week in July.

Injury from flea-beetles has been quite pronounced, particularly on tomatoes and Irish potatoes. Numerous complaints have been received,

and the usual offender has been *Epitrix cucumeris*. The injury by flea-beetles around Easton seems to have been particularly severe, and one trucker reported that he had been obliged to replant tomatoes a third time to secure a stand.

Scandria cerasi was noted as quite injurious in a young cherry orchard near Coleman, Kent County, Md., July 15. At this time the foliage was largely eaten from the trees and the orchard had a browned and burnt appearance. This was the only notable instance of injury from this pest in the State coming under my observation the present year.

Epilachna borealis was reported injuring melons at Denton, Md., under date of August 24. This species has been noticed by the writer both last year and this year in the vicinity of Denton, feeding princi-

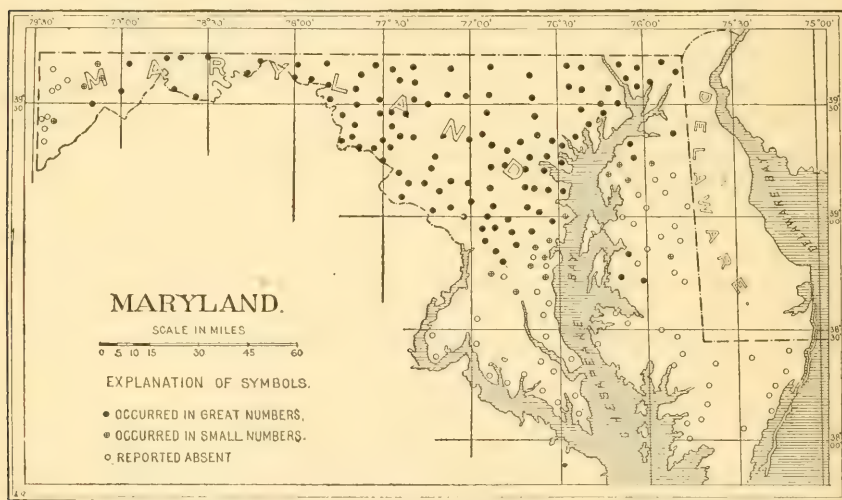


FIG. 2.—Occurrence of Brood X of the periodical cicada in Maryland in 1902.

pally on squash vines. It seems to be well established in this locality, and is more injurious around Denton than any other location in the State with which I am familiar.

The rose-chaffer (*Macrodactylus subspinosus*) was very abundant and destructive in many parts of the State during the greater part of June. Fruits seem to have suffered particularly, and complaints were made in some cases that peaches, plums, cherries, apricots, and pears were largely destroyed. A correspondent at Prince Fredericktown, Calvert County, sent samples of green peaches, the contents of which had been quite excavated by the beetles.

Sweet potato slips were severely injured in the spring in the vicinity of College Park by the several species of *Cassididae*, which feed on this plant. *Cassida bicinctata*, *Cassida nigripes*, and *Coptocycla bicolor* were observed attacking the plants. *C. bicinctata*, however, was the most

abundant. Injury from succeeding broods was not noticed, and the damage apparently was occasioned by the over-wintering adults.

The black peach aphid (*Aphis persicæ-niger*) was noticeably injurious in certain peach nurseries on the eastern shore. Injury was probably at its height by May 1, and later reports indicated that the lice had largely disappeared from the nurseries by the middle of the month. The aphid was occasionally observed on old peach trees here and there in the State throughout the summer. A badly infested peach tree was observed in Frederick December 22 with lice of all ages, notwithstanding the fact that freezing weather had been experienced in this locality on several occasions previous to this date and a heavy snow had just disappeared from the ground.

The apple-leaf aphid (*Aphis* spp.) seems to have been more than usually abundant in early spring, attacking the young unfolding leaves. Many complaints were made of this pest, and it was necessary to prescribe remedial measures. In one instance whale-oil soap at the rate of 1 pound per gallon of water was used without injury to the young foliage. Injury from this insect, however, was not particularly noteworthy during the summer, and complaints largely ceased with the passing of the brood from the over-wintering eggs.

Melanoplus bivittatus was abundant at Hancock and near Keedysville, both in Washington County. In the former instance considerable injury had been done to newly planted apple trees. The clover in an adjacent field had been cut, and the insects turned their attention to the apple trees, quite stripping several adjacent rows of foliage and bark. The grasshoppers were full fledged by June 18, after which date injury soon ceased. Attempts to secure eggs of this species confined in large breeding cages failed utterly, although the insects were given every attention which appeared necessary.

The green pea louse (*Nectarophora pisi*) failed to put in its appearance in time to injure early peas. This seems to have been the case during the last two or three years, and the practice of planting early peas is a method largely in vogue among Maryland growers to avoid injury from this pest. A correspondent from Middleburg sent potato tips thickly infested with the *Nectarophora* sp. under date of June 24. He stated that the insects had made their appearance over night.

The onion maggot (*Phorbia ceparum*) was reported as having been injurious to onions during the previous year by Mr. J. Kolb, of Royal Oak, Md., under date of June 21, 1902. No reports were received of injury during the present year.

The strawberry weevil (*Anthonomus signatus*) has been quite destructive to the strawberry crop both on the eastern shore and in western Maryland. The destructive work of the insect was variously placed by different growers at from 25 to 50 per cent of the crop. Certain

strawberry growers at Ridgely, Caroline County, have determined that the planting of profuse blooming varieties is a satisfactory way of escaping loss from this pest. It appears to be the consensus of opinion that the following varieties, mentioned in order of maturity, are most likely to answer the purposes: Rio, Superior, Tennessee Prolific, and Gandy. While Gandy is not a profuse bloomer, it is quite late, and seems to be the best variety of its season. With these varieties, with the exception of Gandy, the work of the beetles proves to be actually beneficial, by thinning out the bloom. The use of pistillate sorts, as commonly recommended, has not been found satisfactory, and has been largely abandoned.

Injury from the imported elm leaf-beetle (*Galerucella luteola*) was noted July 8 at Frederick, Md. At this time the foliage of certain elms had been largely destroyed. This is the only instance where injury from this species was noted by the writer the present year.

The rose sawfly (*Monostegia rosæ*) became noticeably destructive to roses about the middle of May quite generally over the State.

During July report was received from Mr. Richard Vincent, jr., of Whitmarsh, to the effect that some insect had greatly injured his young celery plants. A careful examination of the celery seed beds was made July 28, and one immature individual of the negro bug (*Corimelaena pulicaria*) was found on the plants, which Mr. Vincent thought to be the same insect which had been so abundant and destructive a short while previously.

The unusual prevalence of the white-marked tussock moth (*Orgyia leucostigma*) in 1901 led some to fear that the insect would again be abundant in 1902. During late May and early June of the present year larvæ of this species were observed in comparatively small numbers, but larvæ of the August brood were exceedingly rare and attracted no attention whatever.

Nests of the fall webworm (*Hyphantria cunea*) were observed quite generally over Maryland during late June and early July, but the second brood failed to show up to any extent.

Mr. Weed presented the following paper:

NOTES FROM NEW HAMPSHIRE.

By CLARENCE M. WEED, *Durham, N. H.*

During recent years New Hampshire has been fortunate in escaping the attacks of several lately introduced insect pests of first importance that have ravaged other States. The most notable of these are the elm leaf-beetle, the San Jose scale, the gypsy moth, the brown-tail moth, and the pear-tree psylla. The last two seasons have shown,

however, that our good fortune was only temporary, for four of these five pests have gained a foothold within our borders.

For several years there has been reason to expect that the imported elm leaf-beetle, which has been so troublesome in other States, would attack the elm trees along our southern borders, although there seemed to be some reason to hope that it would not flourish in the central and northern parts of the State. It was something of a surprise, therefore, to receive from Conway Center larvæ of this pest, with the report that they had been at work upon an elm tree for at least two seasons. To make sure of the identification, the specimens were sent to Dr. L. O. Howard, who said that they were undoubtedly the imported elm leaf-beetle. If this insect can successfully establish itself in the White Mountain region I can see no reason why it should not become a pest in all parts of the State to the southward.

For years I have been expecting the advent of the San Jose scale into our State, but have been unable to find any trace of it until this season. The very fact that there are practically no nurseries in the State not only rendered the finding of the pest more difficult, but made it more probable that it would be introduced without our knowledge. At present two infested localities are known, though it is probable that others exist. In the one first discovered the insect apparently was introduced on a tree set nearly eight years ago, the tree having been purchased from the nursery near Boston which appears to have been largely instrumental in spreading this scale through Massachusetts. In the same neighborhood the pest appears to have been reintroduced last spring on trees bought of a local agent, who had purchased them outside the State. The other infestation, which is at Dover Point, originated from peach trees bought of a local greenhouse man who imports trees from outside the State.

We have as yet no nursery-inspection law in our State, and the scarcity of nurseries would render a law so named something of a misnomer. We need, however, and shall probably get this winter, some law that will be helpful in the matter.

Another pest which appears to have been added to our lists comparatively recently is the pear-tree psylla, which has been destructively abundant during the season at least in Concord and Newmarket. Very likely we shall hear of it in many other localities in the near future.

The brown-tail moth seems to have been first introduced into New Hampshire in the summer of 1899, probably by a severe gale that blew the adults along the coast northeast from Boston. A winter nest of this insect was found in December, 1899, at Seabrook, the southeastern town of the Granite State, by Mr. F. C. Moulton, of the Gypsy Moth Commission, and in the summer of 1901 an adult moth was taken at light in Hampton, the town directly north of Seabrook. No damage from the pest has been reported, but doubtless its general presence in our southeastern region is only a question of a few years.

We have not yet, so far as I know, any evidence of the presence of the gypsy moth within our borders. But now that the State of Massachusetts has practically abandoned its heroic fight against this pest, it seems to be only a question of time when it will spread over our forests. Probably our people will then get a new idea of the possibilities of the damage that may be caused by insect pests.

Canker-worms have been very destructive in southern New Hampshire this year. Our observations show that the spring species is the one chiefly destructive. A comparative test of banding with bodlime and spraying with arsenicals showed that the latter was much the most satisfactory remedy.

On the whole the most puzzling recent entomological event in our region has been the sudden extinction of the hordes of squash bugs that overwhelmed cucurbitaceous plants last year. It does not seem to me possible to attribute this to natural enemies, and unless it was due to the open winter I am at a loss to account for it. It has long seemed to me that this subject of the sudden disappearance of insect pests was one needing careful and continuous investigation by many entomologists working in conjunction, and I venture to suggest that a permanent committee of this association might well be appointed to follow up the subject from year to year.

In New England there has been of late considerable discussion regarding the free use of arsenical preparations as insecticides. While much of the adverse criticism is of course uncalled for and absurd, it seems to me that entomologists should be careful about recommending arsenicals for such crops as cabbages and currants. While there is no doubt that arsenicals can be used safely on these crops, if used intelligently, there seems to be unusual danger that ignorant people will use them too late. Consequently it seems safer to recommend for insects affecting such plants the less dangerous insecticides.

We have found this season that the use of a 5 per cent kero-water spray is entirely efficient against the cabbage worm, and have again demonstrated the effectiveness of insect powder against the same pest. I believe that for our New England conditions these are the most satisfactory remedies.

Mr. Burgess called attention to the reference in Mr. Felt's paper to the willow curculio, and stated that during September of last year he has found specimens of this insect at Ashtabula, Ohio, which is in the northeastern corner of the State. This year it has been found in Lake County, at a point 30 or 40 miles west of Ashtabula. Referring to Mr. Osborn's remarks concerning the chinch bug in Ohio, he stated that early the present spring the prospects for a severe outbreak of the chinch bug in Ohio were very good. A large number of com-

plaints has come to the experiment station during the early spring in regard to this insect, particularly from the southern, central, and southwestern sections of the State; but a little later in the season, probably in June, the weather became wet, and, probably owing to the increase of the fungus disease, the damage decreased to a great extent. He asked if the disappearance of the squash bug had been quite general the present year. He thought that probably many entomologists in the northeastern United States had had a good many reports of its extreme destructiveness, and he had been much puzzled over the complete disappearance of the insect.

Mr. Felt stated in reference to the willow cureculio that he had located it last summer at a point in Chautauqua County, where it could hardly have been carried on stock. In reference to the squash bug, it had not been quite so bad in New York state the present season as last year.

Mr. Fernald stated that the squash bug had not been particularly prevalent in Massachusetts the present year, while it had been unusually so in 1901. He was, therefore, of the opinion that the testimony from Massachusetts would go to sustain Mr. Weed's estimate for New Hampshire. He referred to an interesting German publication by Bachmetjew on the "Temperature relations of insects," which had appeared last summer, which had a bearing on the question of the relative abundance of insects during different years. He considered this a very important paper as relating to the so-called "critical point," and thought the entomologists of the northern United States would do well to test his conclusions.

Mr. Weed remarked that the lack of precise knowledge concerning fluctuations in the abundance of insects had led him to state that he considered this one of the most important economic subjects to be considered at present. These fluctuations have generally been attributed to weather or natural enemies, and he considered that we knew very little in regard to the precise rôle which natural enemies play in regard to our injurious insects. This was strongly brought out by a series of observations by Mr. Fiske and described in a paper which he stated would be published shortly. In this paper Mr. Fiske had detailed his observations on the parasites and hyperparasites of the American tent caterpillar for a period of several years, and his conclusions were, as he remembered the matter, that the parasites had very little to do with the fluctuations of the American tent caterpillar. Very often these fluctuations could be traced to the weather, but on the whole very little was known as to the exact cause which entered into these variations. He thought it safe to conclude that the disappearance of the tent caterpillar two years ago was due to the extraordinary weather conditions just after the hatching of the young larvæ, but he thought it important that definite observations should be made along this line to determine as accurately as possible the real factors concerned.

Mr. Hopkins stated that there was a possibility of variation in a species having something to do with its change in habit from an enemy of secondary to one of primary importance. Referring again to the species *Dendroctonus frontalis*, he had concluded, after a study of many hundreds specimens, that it was a variety of this which was so destructive to the pine forests in West Virginia, and that it had apparently varied from the typical species in a way to enable it to become more destructive. He thought that if it is possible for it to vary in that direction it is also possible for it to vary in another direction, and thus become more sensitive to climatic and other conditions which would exterminate it, as it was exterminated by the severe cold of 1893.

Mr. Felt called attention again to the forest tent caterpillar and stated that in New York State at least the evidence was very largely in favor of the insect being controlled by its natural enemies, for the simple reason that, in looking over the infested areas, it is found that the places where it is most abundant move gradually away from the locality where the original outbreak occurred. These localities of severe infestation have been moving eastward in New York State, and he could readily see how parasites or natural enemies might become locally abundant on account of the numbers of the caterpillars.

Mr. Weed agreed with the opinion held by Mr. Felt, and mentioned one or two localities in New Hampshire which supported this view. He spoke of one region where the Dipterous enemies were very abundant.

Mr. Felt remarked that in regard to the tussock moth in Washington, he believed it to be held that this insect had been largely checked by its parasites.

Mr. Skinner stated that he recalled Mr. Howard's statement in reference to this point, and said that the same condition was true in Philadelphia. It had been his observation that parasites increased largely during the abundance of their hosts.

Mr. Osborn stated that from his point of view it was evident that there was some general influence affecting the abundance of insects, and that there must be some widespread condition also affecting parasites. The squash bug had been present in Ohio, but not so abundant as last year. He had observed that a considerable number hibernated during the past winter. The chinch bug hibernated last year in large numbers and promised to do a great deal of damage the present season, but early summer rains came in such quantities that the insects were destroyed. They practically disappeared in injurious numbers after the first of July. The cankerworm had been very abundant in Ohio, and the fall cankerworm had appeared in considerable numbers, and he thought it likely that it would prove quite abundant in the spring.

Referring again to the forest tent caterpillar, Mr. Weed stated that in New Hampshire, to which State his remarks referred, the facts

appeared to be that the caterpillars hatched and died at the time of a very severe frost in the middle of May. Mr. Fiske had visited the infested regions and saw the caterpillars after having hatched from the eggs, and later they had disappeared. He thought there were no parasites that could have been at work during the brief interval between their appearance and disappearance.

Mr. Alwood observed that many of the entomologists were obliged to give practically all their attention to a few practical problems. He had heard some mention concerning the leaf aphids of the apple. This pest had become more and more troublesome in Virginia and it had been his custom to destroy the eggs in winter by spraying with lye. He had felt quite sure that a great many were destroyed in this way. Yet last winter, although the lye treatment had been given, the apple-leaf aphids had developed enormously and threatened to do great harm. It was therefore necessary to spray them with a soap wash as the buds opened. It was his idea that this insect should be treated in winter by destroying the eggs, and the question was brought up to draw out the experience of others in reference to winter treatment of this pest.

Referring to the woolly aphid of the apple, Mr. Alwood stated that it had become exceedingly injurious in Virginia. Its occurrence in nurseries was the source of considerable concern, and he had not been able to find a practical method of helping the nurserymen. Something was needed that was entirely practical and that could be easily applied to the young growing plants, and not too expensive. He desired to know if anyone had had experience in treating this insect on a large scale. Mr. Alwood also inquired if anyone had actually and positively determined where the female insect naturally deposits her egg. He referred to the considerable literature on this subject, and he had himself found eggs, which he supposed to be those of this insect, but when hatched they were not *Schizoneura lanigera*. He had been able to secure large numbers of eggs in confinement and a few of these had hatched, but he had never succeeded in raising a stem mother to maturity. He had spent considerable time on the life history of this species, but had never quite completed the life cycle. He desired information on this species, and also why it is this pest develops on new land in such enormous numbers in the course of a year or two, thus ruining sometimes as much as 75 per cent of the nursery trees.

Mr. Marlatt said that Dr. Howard had made some careful studies of *Schizoneura lanigera* in 1878-79 (recorded in the Annual Report of the Department of Agriculture, 1879, p. 259). These included the discovery of the true sexed generation and the winter egg, the latter attached within crevices of the bark.

Mr. Hopkins called attention to the fact that Mr. Rumsey, of the West Virginia Experiment Station, had prepared a thesis on *Schizo-*

neura (*Thysoruna*) *lanigera* while at Cornell University. He considered it a most excellent piece of work, which as yet was unpublished. Mr. Hopkins desired to know the present status of the gypsy moth.

Mr. Fernald replied that he had been all over the gypsy moth territory several times during the past summer. At the time when work with this insect ceased, owing to cessation of support from the legislature, the gypsy moth territory had been exceedingly reduced, and in the greater part of that territory the moth could not be found at all, except a straggler here and there, but it would take days of hunting to find it. In the original centers of infestation, namely, Medford, Malden, and Belmont, the moth was still in fair abundance. The work during the later years had been to drive the insect toward the center from the outside. It is not three years since the work stopped, and the moth is as yet scarcely anywhere as abundant as it was when at its worst. So far as he was able to judge, the moth had nowhere spread to its original outside bounds, but it was very bad in a number of places.

The meeting then adjourned, to reassemble on the following day at 10 a. m.

MORNING SESSION—SATURDAY, DECEMBER 27, 1902.

Mr. Marlatt gave an illustrated lecture on applied entomology in Japan, covering the subject of entomological schools and establishments and the practical workers in the science, and also a general account of the principal insect enemies of the more important fruits and field crops. The lecture was illustrated by lantern slides of entomological establishments, charts of important insects, and nearly a hundred views of agricultural and horticultural scenes. The following paper is an abstract by the author:

APPLIED ENTOMOLOGY IN JAPAN.

By C. L. MARLATT.

OFFICIAL ECONOMIC ENTOMOLOGY.

The study of insects injurious to agriculture and horticulture has an official status in Japan in connection with the department of agriculture and commerce, and with agricultural colleges and experiment stations very much as in this country. At the central experiment station at Nishigahara, near Tokyo, is a well-equipped entomological laboratory and experimental greenhouse and gardens, looked after by four or five capable entomologists under the direction of the chief entomologist, Mr. S. Onuki. This is the central and chief entomological bureau of the Empire. Some rather bulky monographs, giv-

ing evidence of being valuable productions on rice insects and insect pests of other crops, have been recently issued from this laboratory. The entomologists connected with it also make frequent trips of inspection throughout Japan and give lectures and talks before agricultural societies and bodies of farmers, carrying instruction in this way into the very homes of the people. Popular publications and placards are also issued. There are nine branches of this central experiment station and, in addition, many provincial stations. Several of these have entomologists, and in some cases very creditable laboratories, as, for example, at Kumamoto, in the island of Kyushu, where Mr. K. S. Shoshima is doing most excellent work.

The important agricultural colleges, as, for example, the ones at Komaba, Sapporo, and Kumamoto give instruction in applied entomology, and have capable men in charge. Many of us are familiar with the excellent work done by Prof. M. Matsumura, of the agricultural college at Sapporo, and of the work of Prof. S. Sasaki, of the agricultural school at Komaba, a branch of the Imperial University at Tokyo. In the regular instruction in zoology, also at the Imperial University in Tokyo, Prof. S. Watase is giving special prominence to systematic entomology.

EARLY NATIVE WORK IN ENTOMOLOGY.

Any review of the work in economic entomology in Japan must include an account of her pioneer and foremost entomologist, Mr. Yasuehi Nawa, of Gifu. Among the pleasantest features of the writer's trip in Japan were two visits paid to Mr. Nawa's establishment in the inland city of Gifu, lying in the great interior valley of the main island of Hondo. Mr. Nawa's interest in the subject developed at an early age, and has been actively prosecuted for the last twenty-five or thirty years with the greatest enthusiasm in his establishment, a sort of entomological academy or school housed in a considerable series of buildings. His own work and that of his students and assistants in systematic and applied entomology is of a most excellent character, and compares favorably with that of our own agricultural colleges and experiment stations. It will be remembered that among the best of the collections of foreign insects exhibited at the World's Fair in Chicago in 1893 was one made by Mr. Nawa, and this collection was afterwards most generously donated to the National Museum.

Mr. Nawa's academy is attended by advanced students and also by teachers and instructors from various educational institutions, colleges, and universities of the Empire. Most of these students are men of mature years who are attracted by the fame of Mr. Nawa and his work and wish to fit themselves for teaching entomology or for special work in the field of applied entomology. Mr. Nawa is now 50 years old,

TRANSLATION OF PLATE I.^a

TITLE: ILLUSTRATIONS OF INJURIOUS INSECTS.

No. 12, *Tsumaguro yokobai*. Food plant, rice.[Translation.] No. 12, *Tsumaguro yokobai* (*Selenocephalus cincticeps*); food plant, Ine (*Oryza sativa*).

DESCRIPTION OF INSECT AND ILLUSTRATION.

The *Tsumaguro yokobai* belongs to the half-winged class of insects, and is the kind known as a leaf-hopping insect. It has four or five broods a year, and is especially an enemy of the rice fields, where it extracts the juices from this plant, killing it or greatly lessening the yield. The male of this insect has the tips of the wings black, but the tips of the wings of the female are uncolored. The eggs are placed beneath or inside the sheath of the leaves of rice, from 10 to 20 together, and that part of the leaf covering the eggs generally changes later to brown. The young insect appears in two colors, one yellow and the other grayish black. When the rice comes into head, these insects gather on the ripening grain and extract the juices to such an extent that the seeds become a mere shell. During the winter this insect inhabits grassy strips along the roads and paths, and is especially found on the grass *Astragalus latoides*. To control this insect the rice seed-beds should be carefully planted in narrow rectangles instead of in a solid mass, and all farmers should cooperate in this respect. To collect and destroy the insects these beds may be gone over with special collecting machines or by sprinkling the water covering the seed beds with kerosene oil and brushing the insects into it. It is desirable to protect the parasitic enemies of this pest.

EXPLANATION OF ILLUSTRATION.—*a*, eggs, enlarged; *b*, single egg, still more enlarged; *c*, young insect after the second molt; *d*, after the third molt; *e*, pupal stage; *f*, male insect; *g*, female insect; *h*, insects injuring the rice plant, natural size; *i*, discoloration of leaves and stem of rice as result of work of this insect; *j*, bee parasite of egg, greatly enlarged. [Japanese lettering rendered in English.]

LETTERING OF RIGHT SIDE.

Copyrighted. Printed 33d year Meiji, November 26; issued same year, December 2. Price 15 cents. Illustration by Shichiro Ito.

LETTERING OF LEFT SIDE.

Author and publisher, Yasuchi Nawa, prefecture of Gifu, Gifu City. Printer, Matsutaro Ôkuma. Place of publication, The Nawa Insect Laboratory, Gifu, Kyo-machi.

^aThe translation of Plates I and II was very kindly made for the writer by Mr. Masanao Hanihara, third secretary of the Japanese Legation, Washington.

and has devoted his life to this work from pure love of the subject and with very little aid other than the laboratory fees, and the results which have followed from his industry and enthusiasm are truly remarkable. In recent years the Government has recognized the extreme value of his work in education and the study of economic problems in entomology, and there is a proposition now on foot to give him a regular subsidy, small in amount but sufficient to enable him to continue his work with greater confidence.

At the time of my first visit to Gifu an annual provincial fair was in progress, and Mr. Nawa was also giving an entomological exposition for which he had been preparing for a number of years. This exhibit was open to the Japanese public, and streams of visitors were going through the gates and paying the small fee to study it. It comprised very much such an exhibit as would be made at one of our general expositions, filled several large rooms, and included cases illustrating the life, habits, and means of control of injurious insects, many illuminated charts and photographs representing insect work, life-history studies, and classification, also models of machinery for the collection and destruction of insects, and, in fact, a complete exhibit of a most creditable order.

The work of Mr. Nawa and his school finds its popular exploitation through a monthly magazine edited by Mr. Nawa entitled "The Insect World." Mr. Nawa also prepares and publishes large charts, each representing one of the more important of the injurious insect pests of rice, mulberry, or other crop or fruit. These charts illustrate in color the damage to the plant and the insect in all stages, give a complete record of the insect's habits for the year, and detail means of control, and are designed to be posted in public places and offices for the benefit and instruction of the rural classes. (See Pls. I and II.) A great many such charts have already been published, copies of most of which were given to me. They are examples of the practical nature of the work which this school is putting forth. In technical entomology some very important monographs have been published which, unfortunately, are sealed works so far as the western reader is concerned.

Mr. Nawa is very materially assisted by his daughter, Miss Taka Nawa, an only child, who has inherited her father's love for the study of insects and is endowed with very decided artistic talent, and is to be credited with many of the beautiful illustrations of insects which appear in the magazine referred to and in the economic circulars and other publications.

If space permitted, mention should be made of several of the assistants and associates who are most efficiently aiding in Mr. Nawa's school and economic work.

TRANSLATION OF PLATE II.

TITLE: ILLUSTRATIONS OF INJURIOUS INSECTS.

1. *Eda shakutori*—Food-plant, Mulberry.

[Translation.] 1. *Eda shakutori* (*Hemirophila atrilineata*); food-plant—Kuwa (*Morus alba*).

DESCRIPTION OF INSECT AND ILLUSTRATION.

The *Eda shakutori* belongs to the scale-winged class of insects or moths, and causes great injury to mulberry trees. It occurs throughout Japan, but is not always recognized, because in the larval stage it mimics a dead branch and is with difficulty seen. There are numerous methods of getting rid of this insect, but the best one consists in collecting the caterpillars in early spring about the time when the leaves are coming out. In doing this the specimens which have been killed by the parasitic bee should not be destroyed.

EXPLANATION OF ILLUSTRATION.—*a*, eggs of this insect on the lower surface of the leaf; *b*, egg, much enlarged; *c*, larva after second resting stage, as it appears in early spring about the time the buds are coming out; *d*, larva after third stage, illustrating manner of traveling by looping its body; *e*, larva in resting position, resembling a dead branch attached or steadied by a line or thread running from the head to twig; *f*, cocoon secreted in decayed hollow of tree; *g*, chrysalis; *h*, male moth; *i*, female moth; *j*, larva killed by parasitic wasp and inflated with cocoons of latter; *k*, male and female parasites; *l*, calendar showing yearly cycle of this insect [outer figures representing the months, counting from the top of the calendar from right to left; inner figures, counting again from right to left, representing (1) egg stage, (2) larval stage, (3) pupal stage, and (4) adult stage; in other words, representing the winter in the larval stage; May and June, pupa stage; July, adult stage; July and August, egg; August and September, larva; September and first of October, pupa; October, adult and egg stage, and winter, larval stage again]. [Japanese lettering rendered in English.]

LETTERING OF RIGHT SIDE.

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LETTERING OF LEFT SIDE.

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OTHER PRIVATE ESTABLISHMENTS.

There are a few other private establishments for the study of entomology in Japan; for example, that of Baron Takachiho, in the island of Kyushu. Here in a well-equipped entomological laboratory excellent work is being done by the baron, assisted by an enthusiastic corps of workers, and including Mr. S. I. Kuwana, whose publications on Coccidæ are well known on this side.

CONTROL OF RICE INSECTS.

Applied entomology in Japan received a great impetus a few years ago from the enormous destruction occasioned to rice fields by certain species of Jassids. The loss in a single year from these insects was estimated at 20,000,000 yen (\$10,000,000). The results of the studies which followed this great loss have been the devising of methods effectively preventing such occurrences in the future. These Jassids do their greatest damage to the seed beds—little flooded areas thickly planted with rice, which, after having made a growth of 6 or 8 inches, is transplanted to the fields. It is found possible to destroy the first brood of these insects in the seed beds by the method which we employ to destroy mosquitoes, namely, covering the surface of the water with kerosene. Immediately after flooding with a film of oil the rice is brushed in such a way that the Jassids are knocked into the water. The oil is then washed off by allowing water to run freely through the beds. In reply to questions as to the possibility of using this oil to destroy mosquitoes, which breed in numbers in rice beds and in rice fields, it was shown that this was impracticable, because the oil could not be left on the rice fields for any length of time without injury to the plants.

In the trip through the island of Shikoku during the month of June the system of Government rice inspection and the enforcement of the kerosene treatment was observed in operation. Supervisory and police regulations have been enacted, compelling the general adoption of this means of controlling these pests. This work is under the general supervision of the central experiment station of the department of agriculture in Tokio, but is carried out by provincial authorities. Rice inspectors, or more properly, rice seed-bed inspectors, are sent out from the provincial experiment stations, of which there are now some 32 in as many provinces, in addition to the 9 branches of the central experiment station of Tokio. The number of inspectors for each province ranges from 5 to 15, and it is their duty to visit every one of the innumerable little farm holdings and see that the plantings for the rice seed beds have been made according to rule and the operations against the insects have been properly carried out. Fines for improperly planting or for omission of remedial treatment

range from 50 sen (25 cents) for the first offense to 5 yen (\$2.50) or more for the second or later cases of neglect. The regulations are to plant these seed beds in patches 4 feet in width with a small path between, and to attend at the proper season to the kerosene treatment. The planting in 4-foot strips instead of in a broad bed, as was formerly the custom, is to facilitate the going through the beds and knocking the rice and jarring the insects into the kerosene-covered water. These Jassids are the most important insect enemies of the rice in Japan, but many other rice insects have been studied and the information gained has been exploited by means of popular circulars. One of these placards or circulars is illustrated in Plate I.

ANCIENT METHODS OF INSECT CONTROL.

Prior to the enormous development of applied entomology in Japan practically on the lines followed in the United States there were undoubtedly certain native methods of controlling insect pests. These for the most part were purely hand methods, which were especially applicable on account of the tiny areas under the supervision of individual cultivators, the rice fields often being only a few yards square, and the orchards and gardens covering only very small fractions of an acre, and perhaps rarely two or three acres. Mr. Hagino, secretary of the local agricultural society of Okayama, in the province of Bizen, informed the writer that during winter as a means of eradicating scale insects, principally the Diaspis on the peach and the Leucaspis on pear, he had all of his trees given a thorough scraping with a little oval knife or blade made from bamboo, and washed the trunks and limbs at the same time with salt water of about the strength of ocean water. The low pruning of these trees and the growing of most of them on trellises, after the fashion of grapevines, rendered it comparatively easy to go over the trunk and branches very thoroughly. The work was done by women, who were able to clean about 30 trees a day. With labor as cheap as it is in Japan this system is undoubtedly inexpensive and fairly effective.

In the adjoining province of Bitchu a proprietor of a considerable orchard, Mr. Watanabe, the pioneer of the fruit industry in that region, in his work against insects employs a lot of boys to beat his trees (peach and plum) and collect and kill curculios and case-bearers, the latter being picked off by hand. The curculio is jarred to the ground by a quick stroke given to the trunk of the tree, and is readily detected by the sharp-eyed boys and promptly crushed. By the same hand methods peach curl and blight are removed from trees.

In northern Japan a primitive method of insect control was witnessed in a vineyard. A patriarchal Japanese gentleman, clad in nothing but his loin cloth, the season being in August and very hot, was observed going slowly about underneath the trellises of a vine-

yard of an acre or more in extent, evidently engaged in collecting insects. He carried a stick or wand in one hand and long shears in the other. The end of the stick had been dipped in some sort of insect lime, and it proved that he was collecting hornets and wasps, which were presumably injuring the ripening grapes. His method consisted in deftly touching the wasp with his wand and catching it upon the lime, and then promptly cutting it in two with his shears. He was so intensely interested in this occupation that he paid no attention to my presence.

SILK INDUSTRY.

The importance of the silk crop of Japan has led to a good deal of experimental work in connection with some of the agricultural stations looking to improvement of methods of silk culture. The insect enemies of the mulberry have also been very carefully studied. A consideration of the silk industry as a whole in Japan would be out of place in this connection. It is an industry which extends practically throughout the Empire, the most important district, perhaps, being in north central Japan, especially about Fukuoka, where the mulberry is grown in great quantities and in orchards of considerable extent. Elsewhere, as a rule, it is grown as a hedge plant or in little garden patches. The trees are cut back each year, so that they often have the appearance of osier willow stumps. Sometimes the young leafy branches are tied up in great bundles and carried to the villages to be sold to local silk raisers, a fairly fixed price being received for these mulberry shoots, which may be kept for several days if stored in a cool, dark place. There is, therefore, a regular business of supplying and selling leaves as well as of raising small batches of worms. The silk output of Japan is the accumulation of the small productions of millions of people rather than of large coöperative or individual operations.

Following this lecture Mr. Simpson read the following paper, also illustrated with lantern slides:

OBSERVATIONS UPON THE LIFE HISTORY OF THE CODLING MOTH.

By C. B. SIMPSON, *Washington, D. C.*

During the past three seasons the writer has been studying the codling moth in the Pacific Northwest under direction of Dr. Howard. The insect in some localities of that region was injuring practically all of the apples, and unless some means were found of controlling it, abandonment of apple culture on a commercial scale was being seriously considered by many growers.

A complete report of this investigation is now in course of preparation, and at this time it is thought appropriate to give some of the more interesting and important results obtained by a study of the life history.

In 1897 Professor Card noticed that the larvæ which hatched from eggs laid upon the leaves would eat out considerable portions of the leaves before entering the fruit. This was stated to occur more frequently in cages than in the field.

In Farmers' Bulletin No. 127 of the Department of Agriculture, Mr. Marlatt notes these observations and suggests that the larvæ are killed by eating the leaves.

Professor Cordley found the past season that two young larvæ just hatched tunneled into the midrib of the leaves, and one of these fed until it was about full grown. In a letter to the writer he concludes as follows:

I believe that with careful attention it could have been brought to maturity on a diet of leaves alone. When one considers that it lived and grew for more than three weeks upon leaves that had been severed from the tree, sometimes for several days, and that it was apparently more thrifty between June 16 and 25 than in the earlier days of its existence, one must acknowledge that, while the proof is by no means positive, the indications are that codling moth larvæ may fully develop on a diet of perfectly fresh apple leaves without ever having tasted fruit.

The writer has many times taken both young and old larvæ and fed them for some time upon leaves, and they seemed to thrive upon this diet, but on account of lack of care and attention I never brought any to maturity. The older larvæ eat the leaves by folding them together and eating out irregular holes. Many observers have noted that the larvæ feed for several days in the calyx when they enter at that place. On examination of the tissue of the calyx one can see that its structure is much like that of leaves. General results obtained by spraying were very satisfactory, and the efficiency of the spraying can not be accounted for by the entrance holes in the fruit in which the larvæ are found to have died. In the spring a great majority of the eggs are laid upon the leaves. In one instance one female moth in confinement laid 20 eggs upon the leaves and 1 upon the fruit, while another laid 22 eggs upon leaves and 2 upon the fruit. Professor Cordley writes that he has no record of a single egg being deposited upon the fruit until after it has lost its pubescence. Later in the season, particularly with eggs of the second generation, the proportion of eggs upon fruit and leaves are found to vary greatly. Some countings made in August, 1902, gave an average of 50 per cent on fruit.

Taking all the data into consideration, the writer believes it safe to conclude that the larvæ of the codling moth can reach maturity on a diet of leaves alone. To what extent this occurs under normal field conditions yet remains to be determined, but the writer believes that

the greater amount of effectiveness of arsenical sprays used against this insect is due to the leaf-feeding habits of the larvæ.

The question of the number of generations was again considered, and all the data secured show that there are two generations at Boise, Idaho, and the possibility of even a partial third generation is very meager. Professor Aldrich states that he has distinguished a partial third generation at Lewiston, Idaho, this past season. I wish to call attention to a misquotation occurring in my 1901 report in regard to Professor Gillette's views as to the possibility of a third generation, as I find that the definite statement that a third generation could not occur was not made by Professor Gillette.

Mr. Marlatt in 1895 gave a relation between the number of generations of this insect and Dr. Merriam's life zones, in which he states that there is one generation in the Transition, two in the Upper Austral, and three in the Lower Austral. In general, I find this to be correct, but in view of new data relating to subzones and partial generations some exceptions must be recognized. I have an immense amount of data on all of these points that is not as yet fully worked over.

In conclusion, I would say that we can congratulate ourselves that the codling moth can be controlled in the Pacific Northwest by quite inexpensive methods.

At the conclusion of this paper Mr. Simpson showed lantern slides, illustrating the life history and numerous methods of control of this insect.

Mr. Washburn next presented the following paper:

A CRITICISM UPON CERTAIN CODLING MOTH OBSERVATIONS.

By F. L. WASHBURN, *St. Anthony Park, Minn.*

It is with a feeling of diffidence that I address you on a topic which is worn so threadbare and has been so well threshed out as that of the codling moth, and I feel that I am probably taking more of the time of the association than is really my due.

Although educated in the East and living in past years in Minnesota, I have spent the last thirteen years on the Pacific coast, and hence come among you as something of a tenderfoot, though a tenderfoot from the West and not from the East.

While at the California experiment station last spring I received bulletin No. 69 from the Oregon station in which Mr. Cordley, who is my successor there, criticises my work done upon the life history of the codling moth in 1892. I later noted a criticism much to the same effect from Mr. C. P. Gillette in the *Entomological News* for June of

the current year. The work was done so long ago it had become as a closed book to me, and it required considerable effort to take up the old thread and recollect just what I had in mind when the bulletin was published.

Mr. Cordley says that I worked out the length of time required in the different stages of the life history of the first brood and then claimed four broods for the Willamette Valley in Oregon upon the mathematical calculation as to the time required. His criticism is a just one, for that is exactly what I did do, the very nature of the case making it impossible to observe the sequence of broods with anything like exactness. He might have gone further in his criticism, for in the bulletin referred to, after making with some emphasis the statement that the moth is four-brooded, I inserted the accompanying table as proof of this, which table really disproves rather than proves it:

	A.	B.	C.	D.	E.
Moths emerge from cocoons.....	June 1	June 20	Aug. 9	Aug. 28	Oct. 17
Egg laying (when moths are about 10 days old) ...	June 11	June 30	Aug. 19	Sept. 7	Oct. 27
Hatching of eggs (5 to 10 days)	June 21	July 10	Aug. 29	Sept. 17	Nov. 6
Life of larvæ in apple (4 weeks)	July 19	Aug. 7	Sept. 26	Oct. 15	Dec. 4
End of larval and pupal stages in cocoon (3 weeks), and emergence of moths.	Aug. 9	Aug. 28	Oct. 17	Nov. 5 or fol- lowing spring.	Emerges the fol- lowing spring.

Mr. Cordley in his critical discussion goes on to say that he has never been able to get a moth to mature as late as October 15. In fact, he writes to Mr. Gillette that he has never been able to rear a moth later than September 15. One at once draws the inference that October 15 or before, in his estimation, marks the last appearance of the imago, and Mr. Gillette, referring to Mr. Cordley's statement that he has never been able to rear a moth later than September 15, cites it as proof that the larvæ of the codling moth begin to hibernate in Oregon as early as the first week in August, which fact he says almost certainly cuts the number of broods to two. Mr. Cordley further says that in column "D" of my table there is an implied inference that at least a partial brood of moths would appear November 5. A glance at the table will show that that matter is left in doubt. I note, too, that Mr. Cordley says my statement regarding a third or fourth brood at Corvallis is without any foundation of fact. What answer would he make then to the fact that I found a moth out of doors as late as November 15? This moth must have originated in an egg laid somewhere between September 15 and September 25, which I believe, though I may be wrong in my assumption, either points to a third brood or to such extreme irregularity in the life history of the moth in western Oregon as to preclude a successful study of the number of broods.

Turning to Mr. Gillette's criticism in the *Entomological News* for June, 1902, page 194, I find this statement:

In Mr. Washburn's table he places the beginning of egg hatching for the first brood of moths June 21, for the second brood August 29, and for the third November 6, and the fourth he does not give, but figured like the others it would come January 15, and the larvæ would not mature before the first week in February. As these dates are to mark the appearance of the brood, the last brood would come much later.

This statement is either very ambiguous, or Mr. Gillette quite misunderstands the table, for I meant to convey the information that the first brood of moths appeared June 1 or earlier.

Referring to the table under discussion, it is to be noted that moths brought me from the apple room on June 20 and referred to in column "B" as brood No. 2 were undoubtedly the latter part of brood No. 1, this first brood running from May 16 (since early moths appeared May 16) to June 20; hence columns "A" and "B" represent the first brood only, and they are naturally followed by "C" and "D." In this way the table works out all right, but for two complete broods and a possible third, not for the fourth.

Mr. Cordley's conclusions in 1898 regarding the efficacy of spraying before June 11 tallies exactly with mine, as well as his observations as to the extreme injury caused later in the season. His notes also as to egg hatching and larvæ affecting the apples (rarely before June 25) are practically identical with mine.

In conclusion I will say that this short paper is not, as is very evident, an attempt to justify my reports in the *Oregon bulletin*, No. 25, nor is it in any way a criticism upon the most thorough work done by Mr. Cordley. I have ventured to present it with the intention of publicly placing the correct interpretation upon the table published in 1893 and wrongfully interpreted at that time. It seems to me that the number of broods of the codling moth in western Oregon is still to be regarded as a matter of some doubt.

A discussion of Mr. Simpson's paper followed.

Mr. Washburn inquired of Mr. Simpson if there were but two broods of the codling moth in western Oregon, and also desired to know the significance of finding a moth as late as November 15.

Mr. Simpson replied that the codling moth varied as much as five weeks in coming out in the spring. He thought the finding of a moth as late as November 15 would not indicate a third brood. Two generations could be accounted for, but the moths of a given generation do not all come out at the same time. Some may come out five weeks earlier than others in the spring.

Mr. Washburn thought it difficult to accurately count the number of broods in a climate like that of Oregon, with which statement Mr. Simpson fully concurred.

Mr. Alwood, referring to the statement made by Mr. Simpson of the cost of 1 cent per tree for spray, desired to know the size of the trees.

Mr. Simpson explained that the trees were 8 years old and much larger than trees of this age in the East. These trees produced from 6 to 20 boxes of apples, with a very good average of 10, a box equaling approximately a bushel. The soda-lime arsenite was used.

Mr. Burgess desired to know the cost and weight of the gasoline sprayer tried by Mr. Simpson.

Mr. Simpson stated that the cost was \$320. The weight had never been accurately taken so far as he knew.

Mr. Fletcher stated that he had been much interested in Mr. Simpson's observations in Montana. He considered the duration of the different broods a very interesting subject and thought that the fact was established that there might be a considerable variation. He questioned the possibility of drawing conclusions from orchard observations alone. Attention was called to the commonly noted occurrence, by anyone who had bred insects, that as large a proportion as half of a brood might go over for a whole period, until the next time of the regular occurrence of the species, and if such observations were made in the orchard, wrong conclusions might be drawn. He did not consider it desirable that entomologists should speak of a partial brood.

Mr. Osborn stated that in determining the number of broods he considered that if the average time of appearance in greatest abundance were taken, results would be much more reliable as a basis for determining the number of broods. He mentioned a case where the codling moth appeared as late as the latter part of June from apples stored in a cellar where it was rather cool and development was retarded.

Mr. Marlatt said that he was very much interested in Mr. Simpson's confirmation of the feeding of the larvæ on the leaves, and not only had this been confirmed, but our knowledge of the extent of such feeding had been much increased. The work of some earlier experimenters and observers had demonstrated that codling moth larvæ would feed on leaves, but that they did it normally and to a considerable extent in nature had not previously been so fully demonstrated. He thought this was a very interesting feature of Mr. Simpson's work. It indicated that the poison catches the caterpillar very frequently on the leaves, especially as it has been shown that a considerable percentage of the eggs are placed on the leaves. When one comes to think of the matter it is not at all surprising that the young larvæ will feed on the leaves. Before entering the fruit they normally work two or three

days in the blossom end on the calyx, and the sepals are practically leaf tissue; they are green and are covered with the leaf hairs, and are to all intents and purposes little leaves.

Mr. Fletcher presented the following paper:

CAN THE PEA WEEVIL BE EXTERMINATED?

By Dr. JAMES FLETCHER, *Ottawa, Canada.*

My object in bringing the subject of the pea weevil prominently before this association is to make an appeal for cooperation to those of our members who hold official positions in those States of the Union where peas are grown for seed. I am led to do this at the present juncture for two reasons. In the first place, the loss from this insect is now very great, amounting annually in the Canadian Province of Ontario alone to upward of \$1,000,000; in the second place, because I believe that from certain exceptional features of this attack, extensive as it is, there is more reasonable hope that it might be entirely put a stop to, than is often the case with an insect injury of anything like the same magnitude; and, further than this, because the present time is most opportune for making a special effort. Owing to the extent of this injury, many growers of peas have relinquished the cultivation of this important crop over large areas where, but for the depredations of the pea weevil, it would be one of the most remunerative crops they could grow.

The life history and habits of the pea weevil are probably well known to everyone here present. I shall therefore merely remind you in the briefest way possible of the leading facts which bear upon its possible extermination. The pea weevil is an exotic insect which feeds entirely upon an exotic plant. It has no other known food plant than the cultivated pea, and this is an annual, which in Canada never survives the winter or produces a volunteer crop the second year from seeds left on the land the previous year, which have failed to germinate. The pea weevil normally passes the winter inside the seed peas and emerges the following spring before or at the time the seeds are sown. A proportion, however, the number of which varies with different seasons, emerge during the same autumn that the seeds ripen, leave the peas, and hibernate in the perfect state. This autumn emergence furnishes one of the greatest difficulties in securing an effective remedy. The weevils which pass the winter inside the peas can be destroyed by the treatment of the seed at any time before sowing; on the other hand, those which leave the peas in autumn hide in various shelters during the winter and can not be reached, but fly to the field

and, together with those which were contained in untreated seed, attack the growing crop. As soon as the new pea pods are formed the females lay their eggs upon them. The larva on hatching eats its way through the pod and enters one of the forming peas. Here it remains until full grown and before emergence has destroyed a large proportion of the contents of the seed it infests. This diminution of the food contents of the grain amounts to over one-sixth of the whole of the large peas and nearly half of the small varieties, but when the grain is required for seed the loss is greater than this. From several experiments I have found that only about 12 per cent of small seeds and 18 per cent of those of the large varieties will produce plants, which are later in developing, and most of them diminished seriously in vigor and crop-producing power.

I have carried on an extensive correspondence with pea growers, grain merchants, and seedsmen with the object of discovering their views as to the most practical method of controlling the pea weevil, and find that all are agreed that the loss is excessive and that some definite action is urgently needed if the paying production of peas for home consumption and export is to be preserved. The pea crop is one of special value to Canadian farmers, not only because no other feed fully takes its place as food for stock and in connection with dairying and hog raising, but on account of the high reputation of Canadian and Northern-grown peas on the European markets. It is also highly advantageous from the farmer's standpoint. The pea being a legume, the soil is enriched in nitrogen by its culture and at the same time the land is left in the best tilth for fall wheat and other crops.

It is generally acknowledged that peas are an advantageous and desirable crop to grow, but it is now a fact that, owing to the pea weevil, they are not being cultivated over a large area where formerly peas of the very first quality were produced and could be again produced if the pea weevil could be controlled. The vital question is, then, Can this be done? I feel confident that it can, but it will require concerted action and cooperation. What, then, is the best and quickest way to reach this end, and what difficulties shall we have to contend with? To begin with, I must acknowledge that, almost with one voice, those I have consulted have expressed the opinion that the only way is to give up growing peas entirely for one or two years, so as to starve the insect out, and to enforce the measure with legislation.

Theoretically, at first sight, this seems to be a perfect remedy, and if a complete cessation of the cultivation of peas were possible no doubt it would be a solution of the difficulty. But after considering this matter very carefully I can come to no other conclusion than that it would be an absolute impossibility to prevent some sowing peas within the breeding range of the insect. For this measure of starvation to be successful, not only would every large pea grower and

farmer within this area, both in Canada and the United States, have to desist from sowing peas entirely, but also every private individual who wishes to grow a few green peas for the table. If laws were enacted looking to this end it would be quite impossible to enforce them. Among gardeners and the general public there is, I opine, neither information nor unselfishness enough to induce them to deny themselves to such an extent as to give up this favorite vegetable for the benefit of other people or of any branch of trade. Even among those who grow and handle peas in large quantities for the market there is a great lack of knowledge with regard to the pea weevil and its habits. Some do not know for certain which of the several enemies that attack the pea actually is the pea weevil. Owing to the prevalent inaccuracy with which popular names are applied to insects, nearly everything in the shape of an insect which attacks crops conspicuously is for the time being styled "the bug." The pea weevil is known generally as "the pea bug," but nevertheless is often confounded with such different insects as the pea moth and the destructive pea aphid.

It therefore appears that what is now most fitting and necessary, as looking to ultimate victory against this enemy, is a vigorous campaign of education through the ready means at our disposal, viz, official reports and bulletins and the agricultural press. All uncertainty should first be done away with and accurate definite knowledge distributed as to the habits of the insect, the best remedies to apply, and when and how to apply them. There are effective sure remedies for the pea weevil; and growers must be made to understand this, and to see that by adopting them, even at some small trouble, they will greatly benefit themselves, while by neglecting them they will injure themselves, their neighbors, and the whole country. I have confidence enough in the common sense of Canadian and American farmers to believe that they will adopt them.

In conjunction with Professor Lochhead, the Ontario provincial entomologist, and Professor Zavitz, the experimentalist of the Ontario agricultural college, at Guelph, this campaign has already been begun by us in Canada. Important meetings of farmers have been addressed, including an assembly of all the farmers' institute workers of the Province of Ontario. During the coming winter the subject will be brought prominently before every farmers' institute meeting held in the Province. Timely articles will be issued advising pea growers not to sow a single grain which has not been first treated, nor to allow seed merchants to sell them peas which have not been fumigated or otherwise treated to destroy the weevil. These measures, however, will only reach a small number of those who are concerned, so no opportunity will be lost of bringing the importance of this subject before the country. The public press in Canada has already done much and

will doubtless do more. In my official capacity I shall do my utmost to bring about what I believe is possible—the extermination of the pea weevil in Canada—and I now make an earnest appeal to the members of this association to cooperate with me in the same direction. If all who sow peas in Canada and the United States will adopt any one of the remedies and carry out the suggestions made below, I am confident that a tremendous advance will be made in a single year, and that as early as the second year extermination might be looked for.

REMEDIES.

Fumigation.—Fumigation with bisulphid of carbon is a sure remedy. When properly done, either in specially constructed buildings known as “bug houses” or in any tight bin, every weevil is surely killed if the seed containing them is fumigated for forty-eight hours with this chemical, using 1 pound by weight to every 100 bushels of seed, or, in smaller quantities, 1 ounce to every 100 pounds of seed. For the treatment of small quantities of seed, particularly by farmers, I have found that an ordinary coal-oil barrel is very convenient. This will hold about 5 bushels, or 300 pounds, of seed, which may be treated with 3 ounces of bisulphid of carbon. Care must be taken to close up the top tightly. This is best done with a cap made specially for the purpose, but fine sacks laid smoothly on the top, over which boards are placed with a weight on them to hold the covering down closely, will answer. Fumigation with bisulphid of carbon is, I believe, the remedy most to be relied on in this campaign. It is perfectly effective, is now regularly used by the large seed merchants, and in future will be much more generally used.

Holding over seed. Where only a few peas are used, a most reliable remedy is the holding over of seed until the second year. Peas should always be bagged up and the sacks tied at once after threshing.

Treating with coal oil.—A remedy which has been used by many farmers with satisfaction is to drench the seed with coal oil, using about half a gallon to a barrel, or 5 bushels, of peas. While applying the coal oil the seed should be placed on a floor where it can be shoveled over constantly to insure the treatment of all the grain.

Scalding seed.—When peas are found at the time of sowing to contain living weevils, these may be destroyed by simply pouring them into a pot of scalding water. The water should be drained off at once or the seed cooled by turning in cold water.

RECOMMENDATIONS.

1. Everyone, when purchasing seed peas, should refuse determinedly to buy any without the assurance that they have been treated; and, further, even after this, he should examine for himself and see that

any contained weevils are really dead. It must be remembered that of weevil-injured seed only about one-quarter will germinate and produce plants; consequently much more seed must be sown.

To secure a supply of seed peas free from weevil injury it will be necessary for growers to handle their crop somewhat differently from what has been the usual practice. This injury is now of an exceptional nature; therefore exceptional measures must be taken to avoid loss.

2. Pea growers should harvest their peas sooner than is usually done—as much on the green side as is safe—thresh them as soon as dry enough, and fumigate them at once or sell to grain buyers, who for their own interest will do so. This treatment has many advantages. Not only is one of the very greatest difficulties in providing a practical remedy—the shelling out of peas in the field—in a large measure avoided by harvesting earlier, but the straw is of a very much higher quality for feed and the seed is heavier and better for every purpose—for export, for feed, and also for seed, because it is of a higher germinating power. In addition to this, the weevil at that time is much less advanced in growth, and consequently has destroyed a much smaller proportion of the bulk of the seed. The average date for pea harvesting is between July 20 and August 20. I have no record of the pea weevil becoming mature and leaving the seed before August 15, and it is usually later than this. Experiment has shown that the weevils at all stages may be killed inside the peas by fumigating them with bisulphid of carbon as soon as they are hard enough to handle. When peas are required for feeding they should be ground as soon as dry enough, and to prevent the meal from becoming musty some old dry peas should be mixed with the new ones. The greatest difficulty of all is with regard to the peas which shell out in the field at the time of harvesting. This, however, will be to a large measure obviated by reaping early, when the seed will not shell out so much as when left till the regular time. The cleaning up of pea fields by turning in hogs is a generally recognized practice, and the work is done very thoroughly by these animals. Where hogs are not available poultry will do the same work, and where neither of these can be used the land should be plowed so deeply that the weevils can not work their way out when they leave the peas.

In the discussion of this paper Mr. Felt remarked that the question was a very interesting one, and speaking as one of the Northern entomologists he desired to assure Mr. Fletcher of his cooperation as far as possible. He did not consider that the pea weevil was as important in New York State as it was farther north. He had looked over the office records extending back as far as eighteen years and noted only two complaints regarding this species. It was his belief that New York parties bought their seed from more northern growers.

He suggested that seedsmen be induced to advertise the fact that their seed peas had been fumigated and thought that this would give them an advantage, in a business way, over those firms who would not take the trouble to do this work. He stated that a number of New York nurserymen had been induced to advertise the fact that their stock had been fumigated, and did not see why this arrangement could not be made with dealers in seeds.

Mr. Weed remarked that it appeared to him that a little pressure might be brought on the seedsmen by having each official entomologist write to the seed growers in his State and ask if the peas being sold by him had been properly fumigated. It was his idea that a list of seedsmen should be published, indicating those who fumigated and those who did not.

Mr. Felt read a notice from Dr. Howard to the effect that entomologists who wished to visit the National Museum collections during Sunday would be admitted on presentation of Dr. Howard's card. This courtesy had been extended by Director Rathbun.

Mr. Marlatt announced that the Entomological Society of Washington, through the courtesy of Mr. W. H. Ashmead, would entertain the visiting entomologists that evening, and extended a warm invitation to all to meet the society at Mr. Ashmead's residence at 8 o'clock p. m.

The meeting then adjourned, to reassemble at 2 p. m.

AFTERNOON SESSION, SATURDAY, DECEMBER 27, 1902.

The meeting was called to order by the president.

Mr. Schwarz announced that there were still a few sets of the publications of the late Dr. Riley which Mrs. Riley had kindly placed at the disposal of the members of the association free of charge. He invited anyone desirous of securing sets of these separates to make this fact known to him.

Mr. Ashmead moved that Mr. Nawa, of whom Mr. Marlatt had spoken during his address in the morning, be made a foreign member of the association. He thought that Mr. Nawa had been doing a good deal for economic entomology in Japan, and that the Association should recognize him for this work. This motion was duly seconded and, at the suggestion of the president, his name was referred to the committee on membership.

The report of the committee on membership was next called for and is as follows:

The committee on membership recommends for active membership: F. C. Pratt, Washington, D. C.; J. Kotinsky, Washington, D. C.; Otto Heideman, Washington, D. C.; W. E. Hinds, Washington, D. C., and H. G. Dyar, Washington, D. C.

For associate members: H. S. Barber, Washington, D. C.; R. P. Currie, Washington, D. C.; G. H. Harris, Washington, D. C.; W. E.

Burke, Washington, D. C.; J. L. Webb, Washington, D. C.; T. B. Symons, Collegepark, Md.; R. I. Smith, Collegepark, Md.; G. W. Martin, Nashville, Tenn.; A. F. Conradi, Durham, N. H., and H. L. Price, Blacksburg, Va.

For foreign membership: Josef Jablonowski, Budapest, Hungary, and Yasushi Nawa, Gifu, Japan.

H. OSBORN,
A. L. QUAINANCE,
NATHAN BANKS,
Committee.

Upon motion of Mr. Ashmead, the report was accepted and the secretary was instructed to cast an affirmative ballot for the Association.

The programme was then resumed, the first paper being by Mr. Alwood, as follows:

A NOTE ON THE OVIPOSITION OF THE SEVENTEEN-YEAR LOCUST (CICADA SEPTENDECIM).

By WILLIAM B. ALWOOD, *Blacksburg, Va.*

In presenting this note I wish first to mention a rather curious observation made by me last year at the Virginia Agricultural Experiment Station at Blacksburg. We were expecting the locusts and had designed, if occasion warranted, to experiment upon some sprays with a view of preventing oviposition by the female in the fruit trees of the experiment-station orchards. At the proper season the insects appeared in great numbers, so abundantly, in fact, that one could gather up a quart in a few minutes at the time they were issuing from the earth. The young orchards at the station were then in the main 12 years old and fine vigorous young trees, but there were also trees ranging down to 2-years set, so that the insects had every opportunity to select suitable branches for oviposition if they were inclined to do so.

Careful observation from day to day revealed the fact that they seemed to be making no efforts whatever to oviposit in the trees of our test orchards, but after lingering for some days in the trees they flew away. Thus by the time the locust season was about half passed our orchards were practically clear of the insects. In no instance did we detect them ovipositing in the twigs or branches of our trees. However, the past summer we have noticed perhaps half a dozen instances where oviposition occurred.

Why they did not choose to oviposit in the branches of the orchard trees at the experiment station has been rather a puzzle to me. I have only one suggestion to make, and that is that, as we spray our orchards very thoroughly with Bordeaux mixture, and the limbs and

twigs were quite covered with a thin coating of the fungicide, this may have in some measure acted as a deterrent to the locusts. I would not like to make the assertion that Bordeaux mixture will deter this insect from oviposition, but the fact observed warrants one in suggesting that it will be an interesting experiment to make when opportunity again presents itself. Other orchards near us were very badly punctured by the female insects.

It occurred to me that it would be an interesting matter to collect data on the various plants chosen by the female insects for deposition of their eggs, consequently I had one of my students follow this matter up quite closely, and he collected the following list of plants, all of which showed the characteristic oviposition of this cicada:

LIST OF PLANTS PUNCTURED BY THE CICADA (CICADA SEPTENDECIM).

1. CONIFERÆ—Pine Family.—Red Cedar (*Juniperus virginiana*).
2. CORNACEÆ—Dogwood Family.—Dogwood (*Cornus Florida*).
3. CUPULIFERÆ—Oak Family.—Alder (*Alnus viridis*); Beech (*Fagus ferrugineus*); Birch (*Betula* spp.); Chestnut (*Castanea americana*); Red Oak (*Quercus rubrum*); White Oak (*Q. alba*).
4. EBENACEÆ—Ebony Family.—Persimmon (*Diospyrus virginiana*).
5. ERICACEÆ—Heath Family.—Blueberry (*Vaccinium* spp.); Huckleberry (*Gaylussacia* spp.); Laurel (*Rhododendron maximum*).
6. HAMAMELIDÆ—Witchhazel Family.—Gum (*Liquidambar styraciflua*).
7. JUGLANDACEÆ—Walnut Family.—Black Walnut (*Juglans nigra*); Hickory (*Carya alba*).
8. LEGUMINOSÆ—Pulse Family.—Locust (*Robinia pseudacacia*).
9. OLEACEÆ—Olive Family.—Ash (*Fraxinus americana*); Lilac (*Syringa vulgaris*).
10. PLATANACEÆ—Plane Tree Family.—Sycamore (*Platanus occidentalis*).
11. ROSACEÆ—Rose Family.—Apple (*Pyrus malus*); Blackberry (*Rubus occidentalis*); Hawthorn (*Crataegus* spp.); Peach (*Prunus persica*); Plum (*Prunus* spp.); Quince (*Pyrus cydonia*); Raspberry, red (*Rubus strigosus*); Raspberry, black (*R. occidentalis*); Wild Cherry (*Prunus serotina*).
12. SALICACEÆ—Willow Family.—Poplar (*Populus* spp.); Willow (*Salix* spp.).
13. SAPINDACEÆ—Soapberry Family.—Maple (*Acer rubrum*); Sycamore maple (*Acer pseudo-platanus*).
14. TILIACEÆ—Linden Family.—Basswood (*Tilia americana*); European Linden (*T. europæa*).

This list shows that 14 botanical families, comprising 30 genera and 33 species of plants, were used by the female cicadas as a nidus for their eggs at our place.

In the discussion of this paper Mr. Schwarz stated that he considered the seventeen-year locust to be one of the most interesting insects we had in this country, and desired that the economic entomologists should bear this in mind in their recommendations for the destruction of the insect. He did not consider the injury done by this species of any particular significance. He thought it to be the duty of economic entomologists to carefully map out the extent and number of broods

of this species, so that it would be possible to accurately indicate to orchardists the time when trees could be most safely planted. The full distribution of many of the broods had never been determined and he considered it very desirable that this should be done.

Mr. Alwood remarked that in his experience injury from the seventeen-year locust had frequently been quite severe. He mentioned an instance where 400 or 500 5-year-old trees in an orchard of 5,000 had been so injured by the cicada that they had been pulled out.

Mr. Marlatt spoke in behalf of the sentiment expressed by Mr. Schwarz, and emphasized the fact that the periodical cicada is our most interesting insect, and thought it would be unfortunate if it were exterminated. He considered that the damage occasioned by it, on the whole, was slight, but that in individual instances considerable injury had been done. He referred to an orchard belonging to Mr. M. B. Waite, near Washington City, where the cicadas had come out from the edge of a woods and had punctured a few of the adjacent rows quite badly, so that one year's growth was lost. Properly cut back, no lasting injury would be sustained.

Mr. Hopkins agreed with Mr. Schwarz as to the interest surrounding this species, and remarked in regard to the broods that he was beginning to be somewhat skeptical as to the propriety of using the term brood with its present significance. He thought that as the knowledge of this species increased it would be found that there was a great deal of intergrading, and also that representatives of so-called broods were likely to appear every year, even in the same State. He had evidence from West Virginia that the periodical cicada appeared annually in certain localities. He thought it would be very difficult, except where the intervals were marked, to designate them as distinct, or to refer each to a recognized brood.

Mr. Marlatt called attention to the work of Dr. Gideon B. Smith, who lived in the first half of the last century, and who had studied the cicada very extensively between 1825 and 1850, or thereabouts. Dr. Smith had prepared a very important paper, which he had never published. An abstract of Dr. Smith's record of broods had been published in the speaker's paper on the cicada (Bulletin 14, United States Division of Entomology). Dr. Smith had called attention to the idea just advanced by Mr. Hopkins, namely: The fact of the gradual breaking up of old broods, which in the course of time might cause the cicada to appear in every cicada-brood region every year. This did not mean that the seventeen-year period would be lost, but that there would be such a splitting up of the broods by acceleration and retardation that the marked periods of appearance in considerable numbers would cease.

INJURIOUS INSECTS OF THE YEAR IN CANADA.

By JAMES FLETCHER, *Ottawa, Canada.*

The season of 1902 in Canada has been a remarkable one, being of an unusually damp and cool nature. This has had an effect not only upon the development and yields of many of our staple crops, but also upon the prevalence of some of the important crop pests. There was a noticeable absence of injury by some of the best-known insect enemies of cereal and orchard crops, such as the Hessian fly, the wheat-stem maggot, the codling moth, the plum curculio, the cankerworms, and the tent caterpillars. Peas, formerly such an important crop in Ontario, were little sown this year, from fear of the depredations of the pea weevil, and some substitute crops, such as the grass pea, soja beans, emmer, and clovers, were cultivated in their place. The season, however, was inauspicious, and these crops were not grown with satisfaction. The season, although favorable for most fodder crops, was adverse to corn, the most important of all, over large areas.

INSECTS AFFECTING CEREAL CROPS.

Grain crops were little injured by insects during 1902 and yielded unprecedented returns. There was an almost phenomenal disappearance of the Hessian fly in western Ontario. No injury appears to have been done, although during the season of 1901 both the occurrence of the insect and its injuries were excessive. A serious outbreak of the Hessian fly, however, occurred in Manitoba, and the losses were doubtless far more extensive than was recognized, owing to the enormous crop. In Manitoba there is only one brood of this insect, the flies of which appear in spring at the time wheat is just sending up its stems. Larvæ from eggs laid upon the young leaves and hatching before the stems shoot up, attack the root shoots and do much harm, although this is seldom noticed by farmers. Those larvæ which hatch later locate at the bases of the leaves of the lowest joints of the stem. The "flax-seeds" are formed by the end of June, but the flies do not emerge till the following spring. Cutting high and the burning over of stubble are recommended as remedies.

LOCUSTS.

A considerable amount of injury was done in Manitoba during the past season by the Rocky Mountain locust, the lesser migratory, Packard's, and the two-striped locusts. My object in mentioning this now is to draw the attention of entomologists to the Criddle mixture of horse droppings poisoned with Paris green or some other convenient insecticide. Full details of this method have been given in my later annual reports which, according to the constitution of this association,

are regularly sent to every member. I need not, therefore, take up time now in repeating these further than to say that the mixture has been improved during the past year by Mr. Criddle and that it has been eminently satisfactory in controlling locusts. The mixture now consists of 1 pound of Paris green mixed with 60 of fresh horse droppings. To this is added 2 pounds of salt and the mixture is then scattered round the edges of fields which it is thought may be invaded by a swarm of locusts. This remedy, of course, is also available for grasshoppers in all parts of the country. The most convenient receptacle for mixing this and carrying the material to the field is half of a coal-oil barrel mounted on a cart. A piece of shingle answers well as a paddle to distribute the mixture with.

The injuries by the pea weevil and the possibility of eradicating it I have already laid before the meeting in a separate paper. This is perhaps the entomological problem of most importance in Canada to-day.

INSECTS AFFECTING ROOT CROPS.

Root crops throughout the Dominion have been exceptionally fine and there was little complaint of injury by insects. The Colorado potato beetle was complained of in the new Mormon districts of Alberta, lying in the foothills of the Rocky Mountains, also in Manitoba in a few localities, but was not a cause of much loss. In Prince Edward Island, on the other hand, it was extremely abundant and destructive, owing, perhaps, to an unusually hot and dry period which prevailed during July.

Some injury was complained of to potatoes in Manitoba by blister beetles. This was to be expected as a consequence of the abundance of grasshoppers during the last four or five seasons.

The turnip aphis (*Aphis brassicæ* L.), which for many years has been very troublesome in Canada, was abundant this year only on the Pacific coast and in Newfoundland. Its attacks were chiefly on cabbages.

INSECTS AFFECTING FRUIT CROPS.

The eye-spotted bud-moth.—Fruit crops have on the whole been very satisfactory. In the apple orchards of Nova Scotia there was great irregularity of production, some orchards being heavily loaded while others close to them had very poor crops. This I attribute largely to the temporary abundance in the maritime provinces of the eye-spotted bud-moth (*Timetocera ocellana*), which I detected there last winter on the trees in the larval condition and in remarkable numbers. It can not be denied, however, that Canadian fruit farmers have progressed enormously during the last half decade, as is testified by the general adoption of spraying and other common-sense methods of

advanced horticulture. The self-styled "practical man of experience," who wants no science, as he calls it, but does everything in a rule-of-thumb manner, comes to grief and loses money every time he comes in contact with the really practical man, who does not brag about being one, but who wants always to obtain from specialists the best and latest information on all branches of his work.

The San José scale.—Introduced into Ontario in 1897, this most pernicious enemy of the fruit grower has spread through that part of Ontario lying between Niagara and Hamilton, and west of that line to the Detroit River. In fact, it now occurs throughout the peach-growing districts which lie to the west of Lake Ontario and to the north of Lake Erie. This small area is the only part of Canada infested by the scale; but splendid work has been done by the provincial government through its officer, Mr. George E. Fisher, the inspector of San José scale, who has been constantly at work since 1898, and his results have been such that they seem worth bringing before the Association. I think it may now be claimed that with the lime-sulphur-and-salt wash, or with a modification of this in which the salt is omitted, as a winter wash, followed in summer by the ordinary kerosene emulsion, we have a practical remedy by which the San José scale can be controlled. The Federal Government is enforcing strictly the San José scale act, which is practically the one that was agreed upon at the Washington conference held in January, 1898. It is unfortunate that the United States Congress did not simultaneously put through the similar act which was agreed upon at that time, but which it will be remembered was neglected owing to the outbreak of the Cuban war. Had this bill become a law the two countries could have worked together to prevent the transshipment of infested nursery stock from one to the other. By the Canadian San José scale act all nursery stock imported from countries where the scale is known to exist is fumigated entirely at the expense of the government. There are six ports of entry where fumigating houses are located, and these have worked admirably. The San José scale act has been rigidly enforced, and with excellent results, for there has not been a single well-founded complaint of injury to stock, of undue delay chargeable to the fumigation, or of living scales having been found on any trees in the large number of consignments of nursery stock which have been imported into Canada through the fumigation stations.

The attention to fruit pests, especially to all kinds of scale insects, which has been evoked by the advent of the San José scale in Canada, has had a good effect by teaching our fruit growers and farmers the importance of knowing more about the insect enemies of their crops and the necessity of careful definite work in all branches of their business.

New fruit pests.—Some new enemies of fruits, perhaps of only minor importance, but worthy of mention here, are the following:

The blackberry soft scale (*Eulecanium fitchi* Sign.) and the rose scale (*Aspidiotus rosæ* Bouché) appeared in injurious numbers in several localities in western Ontario in blackberry plantations.

A noctuid (*Scopelosoma tristigmata* Grote) and a geometer (*Mesoleuca truncata* Hufn.) were sent in from Vancouver Island as having done harm in strawberry beds.

A single specimen (the first recorded) of the brown-tailed moth (*Euproctis chrysorrhæa* L.) was caught at light in St. John, New Brunswick. I do not think that this means that the insect has spread to New Brunswick from Massachusetts, but rather that a moth or the pupa was brought direct from Boston on one of the many passenger ships plying regularly from that port to St. John. It indicates, however, how easily this or any other insect might be spread to a new locality.

Of rather more importance than the above-mentioned is a new injury reported this season from several places in western Ontario and observed in a few cases last year at Ottawa, by the larvæ of the sawfly (*Taronus nigrisoma* Nort). These larvæ are frequently found in autumn on different kinds of *Rumex* and *Polygonum*, of which they reduce the leaves to a skeleton. The injury to apples is done by the green larvæ boring into the fruit in autumn. From the appearance of the burrows, which run in for about half an inch into the flesh of the apple and which contain no black excrement, I am led to hope that this is merely an accidental injury, the larvæ merely boring into apples as they might into any soft, firm substance, in which to excavate their winter quarters. The usual habit is for the larvæ to bore into the pithy stems of herbaceous plants. I have no record of the larvæ attacking the leaves of apple trees, but Professor Lochhead, of Guelph, saw these larvæ climbing up the trunks of apple trees in October. The injury to fruit was, however, of rather a serious nature, the apples being much disfigured, and in many instances they were rendered unfit for market and had to be fed to pigs. Should this sawfly larva become a regular enemy of the apple, a remedy which suggests itself is the destruction of all weeds growing near the trees which belong to the dock or smart-weed family.

FOREST INSECTS.

The birch skeletonizer (*Bucculatrix canadensisella* Chamb.).—The birches, particularly the white birches, throughout the greater part of Canada east of the prairie provinces have been greatly disfigured during the past two seasons by the small larvæ of this tineid. Owing to the cool, damp season of 1902, the attack was not apparent until a fortnight later than in 1901, and it is hoped that the ultimate effect on

the trees will be less severe. Birches, however, were in many places entirely defoliated by the middle of September. The destructive work of these caterpillars was also considerably added to by a large aphid (*Callipterus mucidus*) and by a green leaf-hopper (*Empoasca smaragdula* Fall.).

Mr. Washburn in discussing this paper stated that the locust trouble was a very interesting one in Minnesota, and also a very serious one. He stated that the farmers were very slow in using poison bait, such as bran and horse droppings, because poultry roam over the wheat fields, and in scratching over the poisoned droppings would suffer. For this reason it was almost impossible to use the poison bait in Minnesota.

Mr. Alwood inquired if anyone had ever poisoned chickens with an arsenite.

Mr. Fletcher stated that he had been investigating this point for some years, but had never heard of a single instance.

Mr. Marlatt made the suggestion that ordinary white arsenate be used instead of Paris green, the former being very much cheaper. He said that Paris green is the most expensive of all arsenicals, costing 20 to 25 cents per pound, whereas arsenic could be purchased at a few cents at the most. He said that the simple arsenite of copper was as effective as Paris green, and could be purchased for about one-half the cost of the latter. Difficulty was experienced, however, in procuring the arsenite of copper in sufficient quantities to supply the present demand; hence he thought Paris green (the aceto-arsenite) would no doubt be largely used for some time to come. As relating to this particular case, he was inclined to recommend simply poisoning the bait material with white arsenic. He suggested that an enormous quantity of poisoned material would be necessary to insure the destruction of the locusts in their widespread outbreaks.

Mr. Fletcher explained that it was not necessary to cover an entire field, but that the poison should be placed around the edges. With regard to the use of arsenic as a substitute for Paris green he considered this very undesirable, from the great danger of poisoning from its accidental or careless use. He thought arsenic resembled flour, sugar, and some other household stuffs too much to allow of its general prescription. The reason that he had continued to recommend Paris green was that it is well known, and could not on account of its warning color be mistaken for anything else. He would have no hesitancy in using arsenic himself or advising its use by specialists, but would not dare recommend it for everybody, and particularly if it were likely to be kept about dwelling houses in the country, as a result from having some of the poison left over. Fruit growers living

at a distance from towns, or for the sake of economy, generally buy more materials at once than they require to use at the time. No matter how great the danger may be, people soon get careless.

Mr. Marlatt desired to know what objections there would be to the use of the simple copper arsenite as a substitute for Paris green.

Mr. Fletcher stated that he preferred the former to Paris green in some ways, not only on account of its being cheaper, but from the fact that it was susceptible of much more even distribution in the water, but it seemed also more likely to injure foliage. He had used disparene with great satisfaction.

Referring to the danger of poisoning fowls by poison bait scattered in the field, Mr. Wilcox stated that about a year ago he had had occasion to read an extended article bearing directly upon this point. Several forms of arsenical poisons had been tried on chickens and pigeons, and also, as he remembered it, on ducks. The details of the test had passed from his mind, but he was greatly impressed with the very large quantity of poison which fowls could eat before they were affected by it.

Mr. Fernald called attention to an interesting observation which he had made in the course of his nursery-inspection work in Massachusetts, namely, that he had found the San Jose scale occurring on the arbor vitæ and also on the white spruce. While he hardly thought that the insects would be able to permanently establish themselves on these plants, yet he desired to call attention to the matter.

Mr. Kellogg then presented the following paper:

NOTES ON CALIFORNIA COCCIDÆ, ALEURODIDÆ, AND SCOLYTIDÆ.

By V. L. KELLOGG, *Palo Alto, Cal.*

Mr. Kellogg made a brief report on the work being done at Leland Stanford Junior University on the Coccidæ, Aleurodidæ, and Scolytidæ of California. A collecting trip was made in the summer of 1901, by foot and horseback, for a thousand miles through the great coniferous forests of northern California for the purpose of collecting specimens and notes for a study of the conifer-infesting scale insects. Mr. Coleman, the assistant who undertook this trip, brought back 22 species of Coccidæ from 26 species of conifers, 10 of the insect species being described as new. Of these 10 the immature stages of 4 are described and a complete life history of 1. A graduate student, Mrs. F. E. Dorsey, has described 20 new species of Aleurodidæ found in California, thus increasing the number of known North American species in this family from 40 to 60. In the case of every one of these 20 new species the immature stages have been studied by Mrs. Dorsey and described. Experiments have been carried on in combating *Dendroctonus valens* in Monterey pines in the arboretum of Stanford University, in the

grounds of Mr. Timothy Hopkins at Menlo Park, and in the grounds of the Hotel del Monte, on the Bay of Monterey. Small, close canvas tents have been put around the trunks of the trees, and in these tents hydrocyanic acid has been used. This gas readily penetrates the burrows of *Dendroctonus* and kills practically all of the larvæ and adults in the burrows. As many as 300 larvæ have been found in a vertical length of 3 feet of trunk, and all of these larvæ have been killed by the gas. Such a procedure is, of course, not at all practicable in fighting *Dendroctonus* in forests, but seems to offer a means of killing the pest when attacking a few choice trees, as is the condition in the parks and grounds in the neighborhood of the university.

PLANT ENVIRONMENT AND INSECT DEPREDACTIONS.

By F. WILLIAM RANE, *Durham, N. H.*

We are constantly learning something new about the relationship between insect and plant life. A new species hitherto unknown is discovered, and shortly it may be this insect lays claim to some of our domesticated plants, and thereafter continues to menace or prey upon it as commonly as though this had ever been its custom. Again, species that we have long known for some reason change their appetites, or rather enlarge upon their food supply, so as to include in their *menu* plants heretofore not cared for. Such events are constantly taking place, and entomologists are ever ready to make new observations. To find an old friend taking a meal on a heretofore strange plant is noted with interest. Although experience has shown that these simple observations may not indicate much, yet they are important, for as time goes on conditions may arise wherein this indicated outbreak may occur.

Economic entomology has come to be a great factor in America, and, with an ever-increasing number of keen observers everywhere throughout our broad land, little happens that is not soon brought to the notice of someone.

The gardener, fruit grower, or farmer that is awake to his calling has a remedy or suggestion at his bidding for most of his insect foes. These remedies are generally looked to by him as cure-alls, and if the insects are only destroyed everything is lovely.

The point that I desire to emphasize in this paper is that simple remedies for insect depredations in many cases are not after all what really is needed. It was not many years ago that everyone had his own remedy for certain insect depredations, and each man that made a success attributed it to his particular treatment. Modern investigation, however, exposes many of these practices as absolutely imprac-

tical. The reason for their success, in other words, was due to other conditions entirely. I remember carrying out an experiment to protect cucurbits from the *Diabroticas*. Upon collecting all suggested remedies and tabulating them, over 50 were offered. These were tested and, strange to say, none of them were efficacious as recommended.

We are yet in the transitory stage as regards the use of insecticides from the practical man's standpoint. He hears so much about spraying that he thinks if he sprays his crops he is practically assured of a harvest. I feel that, in regard to the use of insecticides, we are likely to duplicate the experience of a prominent chemist with the commercial-fertilizer problem. When commercial fertilizers first came into use he most heartily championed them, and tried in every way to show wherein they were of value, but farmers generally thought them a myth and didn't want to have anything to do with them. Now this same man says the pendulum has swung to the farther extreme. Public sentiment, through the press, bulletins, fertilizer companies' publications, etc., make a person feel that to be without commercial fertilizer is courting failure. In other words, this same man now feels it his duty to caution against the indiscriminate use of these goods, which are without doubt as great a drawback to financial success in some sections as anything.

Our position as regards insect depredations in some States I am inclined to think analogous to the commercial fertilizer problem. I do not desire to be considered as throwing any cold water on the progress of economic entomology, in which field I am ever ready to thankfully accept everything of usefulness. But from the standpoint of the farmers, fruit growers, or gardeners much emphasis should be laid on the fact that though the insects themselves may be destroyed, this does not necessarily insure the conditions desired.

Is it not a fact that those men who are the most negligent about their general knowledge of plant culture have the greatest trouble from insect depredations? I believe that our best entomologists will bear me out in saying that wherever we find practical successful husbandmen we also find the minimum trouble from insect depredations.

It is not an easy matter to lay down any specific and definite law, but that these conditions do exist there is little question. Many insect ravages are doubtless the resultant of an unhealthy condition of the plant, due to improper culture or accident rather than to the natural devouring instincts of the insect. Trees that are girdled or cut down are shortly preyed upon by a great variety of insects that nature evidently considers beneficial, although they are, under some conditions, detrimental. Where cultivated plants that naturally need plenty of available plant food for their development are set out in depleted soil, from the very fact of their previous high degree of culture and breed-

ing they begin to decline, and plant-lice and other insects assist in their extermination. I had three vines (*Lonicera*) running over my porch. All grew well for a couple of years, when one became badly affected by plant lice, while the others were comparatively free. Upon examination I found that the label wire that had been left on the infected plant was checking its development, and the vine was thereby weakened. Upon removal, new shoots rallied to the support of the plant, but the insects were too numerous and the plant became discouraged, although it never thought of giving up life. The next year I noticed that this same plant was again affected with the aphides, also one of the others, but the third seemed healthy as ever. Upon diagnosing their cases I found the healthy one stood alongside a shrubby border, and its roots had ready access to rich cultivated soil, while the others were in sod ground. Thinking the poverty of their food supply perhaps accountable for their condition, they were fertilized, with the result that, although the insects did not leave the plants entirely, the plants themselves overcame their previous debilitated condition and, as far as the casual observer could tell, were perfectly healthy. Many other facts have come to my notice that also point to the conclusion that, if we understood what the proper culture of the plant should be, many insect troubles could be avoided. I have taken much interest in getting the practical man's views of plant culture, and many object lessons are gained therefrom. Insects and fungous diseases are by no means as troublesome to the man who knows how to get best results from plants themselves as they are to another who knows everything about insects and their control and but little about plant culture.

I have had college graduates who could identify insects and recite on insecticides perfectly, but who found it practically impossible to combat red spider and the like without practically destroying the value of the plants themselves. Another man with little knowledge of entomology or insects, but thoroughly understanding plant culture, has grown the same plants under exactly similar conditions, and I have failed to even find red spider present. If plants are allowed to suffer from crowding, over or under watering, too much or too little ventilation, extremes of temperature, insufficient plant food, neglected breeding, etc., of course one will have trouble, and simple remedies, although under other conditions they might be efficacious, here are utterly useless. I might enumerate further examples, but hope I have sufficiently emphasized the idea that entomologists can not know too much about plant culture, and were it possible I should like to see every economic entomologist as far as possible a practical grower.

The next paper was by Mr. Phillips:

NOTES ON MELANOPLUS FEMORATUS.

By J. L. PHILLIPS, *Blacksburg, Va.*

This locust was first observed in considerable numbers by the writer, in Roanoke County, June 17, 1899. It was in this instance doing considerable injury to a small field of timothy, but was not plentiful enough in the vicinity to attract general attention. Where this insect occurred in considerable numbers, the grass was entirely unfit for hay, as they cut off or destroyed all the blades, and many of the heads, leaving only the stalks. This species was found to be plentiful in the fields near Blacksburg, later the same summer, but it was not present in sufficient numbers to do serious harm.

The observations were not carried on systematically, very little attention being paid to it in 1900 and 1901, but on June 16, 1902, we learned that this insect was doing considerable damage in some portions of Wythe and Smyth counties, about 50 miles west of Blacksburg. This outbreak was investigated at once, and proved to be the most serious one known to us.

The owner of the property where this outbreak occurred claimed that the locusts were first observed on the western border of a pasture field of 30 acres. At the time this investigation was made, the majority of the insects were located in a 20-acre field of wheat, adjoining the pasture field. They had eaten all the herbage on the above-mentioned pasture, leaving the ground bare, but the roots were still alive and had begun to send up a straggling new growth. The wheat was already considerably damaged. Nearly all the blades had been cut off, and many of the heads of wheat also, and they were still feeding. The great majority of the locusts were adult at this time.

Mr. Browning, the owner, claims that on former occasions he had known them to destroy much of the wheat after it was shocked, even cutting the twine bands, so that there was some loss in handling.

These fields are located on the eastern bank of a small stream, which appears to have acted to some extent as a barrier, preventing their entrance to the fields on the west side in any considerable numbers. Later observations this season showed this insect to be present in numbers all through the Valley of Virginia, from Smyth County on the southwest to Frederick on the north. July 22, a small apple orchard near Winchester, about three years set, was found to be almost defoliated, and investigation proved that this insect was responsible for the damage.

Mr. Symons next presented a paper on the following subject:

ON THE POSITION OF THE SETÆ OF THE SAN JOSE SCALE IN INFESTED PLANTS.

By T. B. SYMONS, *Collegepark, Md.*

[Withdrawn for publication elsewhere.]

Mr. Hopkins stated that in his opinion the subject of Mr. Rane's paper was worthy of careful consideration, as it had to do with quite an important subject. In his own official work in West Virginia he had frequently urged the importance of good culture and good farming in the control of injurious insects, and thought that farmers who gave proper attention to these points would succeed where careless farmers would often suffer severely from insect depredation. This statement did not refer to all insects, but he thought there were many species which are attracted to the less vigorous plants and that such plants succumb while more vigorous ones would repel them or recover the injury.

Mr. Rane stated that the idea of presenting this paper had come to him from observations on men graduating from our educational institutions, especially those going out into economic scientific work. He thought men preparing themselves for work in entomology should be given a considerable amount of work in horticulture and agriculture. If they did not understand these subjects, particularly from the practical standpoint, they were greatly handicapped. He stated that he had had an opportunity of observing the work of a number of young men who had made a study of entomology, and he thought them to be incapable of successfully handling their work in relation to crops. A man might be well fitted for entomological investigation, but would nevertheless not be practical in his recommendations for farmers and fruit growers. He thought the same held true of plant pathologists. A knowledge of entomology, botany, plant pathology, etc., is always to be recommended, but equally so, for the benefit of the results to be derived from plants is a knowledge of ideal plant environment, which is none other than culture.

The following papers, which had been handed to the secretary, were read by title and were accepted for publication in the proceedings of the association.

DEVELOPMENT AND HIBERNATION OF MOSQUITOES.

By H. A. MORGAN and J. W. DUPREE, *Baton Rouge, La.*

Data in connection with the development and hibernation of mosquitoes is of the greatest interest in determining rational remedial measures. As most of the investigations up to the present time have

been inspired by a desire to reduce the numbers of these pests, to make habitable at certain seasons of the year large areas that may be devoted to a variety of enterprises, and to check the spread of diseases, our studies were begun with the idea of assisting as far as possible in this laudable cause, and we trust that some of the facts as set forth in this paper may prove of value in future work upon this subject.

The mosquito genera that have come under our observations are *Stegomyia*, *Culex*, *Conchyliaetes*, *Psorophora*, and *Anopheles*, and as many as 24 species have been studied more or less. We had expected to discuss our observations upon all the species common to Baton Rouge and vicinity, but it would take more time than that usually allotted to the discussion of a single topic on occasions like this. We have, therefore, thought best to discuss in a general way the problems associated with the hibernation and development of mosquitoes as a whole and to discuss in detail, though briefly, the life cycle of *Psorophora*.

The time required for the transformation of mosquitoes, as with most insects, is decidedly a variable quantity, dependent upon food and temperature conditions, and thus statements of so-called normal life of mosquitoes are misleading unless accompanied by the exact conditions under which this information was procured. While with most students of insect development, a knowledge of conditions is assumed, yet public sentiment, upon which science is more or less dependent for the operation of remedial measures, is seldom conversant with details of conditions, and if remedies fail much time is lost in explaining the reasons why failure occurred.

RESULTS OF OBSERVATIONS ON MOSQUITOES.

From our studies of mosquitoes in general we have observed the following:

First. That local pools are common breeding grounds for most species of mosquitoes. Of the 24 species found here every one has, in some stage of its development, been taken from a small pond 10 feet long, 4 feet wide, and of that depth that two weeks' drought was sufficient to evaporate all the water it contained. The lack of enemies of mosquitoes in such places may largely be responsible for the prevalence of such a variety of forms of variable life history.

Second. That most mosquitoes deposit eggs singly upon the surface of the water (exceptions are *Culex pipiens*, *C. consobrinus*, and possibly one or two other species) and, except in the cases of *Anopheles* and those placed in boat masses, the majority will sink to the bottom of ponds or breeding vessels.

Third. That the sinking of eggs and low temperature, as well as the rapid evaporation of the water of pools on which eggs are laid, produce

in a marked degree variations in the time of hatching. Eggs of *Stegomyia fasciata*, *Conchyliates musicus*, *Psorophora ciliata*, and *P. howardii* have been influenced to the extent of months in the time of hatching by one or other of the above conditions. This point should not be lost sight of in devising plans for the extermination of mosquitoes, and emphasizes the possible variability of life cycles under such conditions.

Fourth. That the hatching of eggs of many species is in some way associated with agitation. In ponds that dried up and remained so for months very small larvæ of *Conchyliates*, *Psorophora*, and a few species of *Culex* could be found in a few hours after sufficient rain fell to produce currents and a shifting of the eggs. In the laboratory eggs were hatched by agitation, while members of the same batch left undisturbed remained unhatched for months. Seasons of occasional showers may be responsible for the prevalence of mosquitoes in more ways than one.

Fifth. That ordinary transient ponds and pools furnish sufficient food for the rapid development of larvæ to make the presence of water only necessary for a period of six or eight days to insure the perpetuation of many species of mosquitoes. On the other hand, water containing but little food that is not subject to complete evaporation may prolong the larval life for months. We have observed the life of *Stegomyia* larvæ prolonged under such conditions two months and eleven days.

Sixth. That the larvæ of mosquitoes are not so fastidious in their food habits as they are reputed to be, but that water saturated with fecal matter will shorten the larval period of many species. *Stegomyia* under such conditions completed the life cycle in from six to eight days.

Seventh. That water is not essential to the life of pupæ of many species, so long as the ground upon which they rest is moist. Under the latter condition the pupal period is frequently shortened. This is of importance in connection with the proposed remedy of sweeping gutters in which mosquitoes breed. It also has a bearing upon the transient pools as breeding places for most species. In our experiments pupæ were kept as long as three days upon moist cotton before emerging.

Eighth. That most larvæ and pupæ can remain under water a sufficient length of time to be able to survive in cisterns full of water, and that the habit of larvæ, some at least, of bringing to the surface more food than can be devoured at once assists a colony of specimens to procure food without having to go to the bottom for individual feedings. The data associated with the cisterns as chief factors in mosquito production is not sufficient to draw permanent conclusions. One thing is certain, that water blocked in gutters of buildings by

leaves and other material, as well as defective grading of gutters, produces conditions similar to those of the transient pools, so important to the present mode of life of mosquitoes.

Ninth. That the hibernation (i. e., where mosquitoes hibernate or winter in a specific stage of their development) takes place in the species we have studied in the egg and adult conditions. Dr. John B. Smith calls attention to the hibernation of two forms in the larval stage, but up to the present these species have not been observed in Louisiana. Several species keep on breeding through the winter, but development is slower and fewer broods occur, owing to scarcity of food and relatively lower temperature. Even with some of the true hibernating forms long warm spells may bring the stages out of winter quarters. From the above it is plain that mosquitoes are not uniform in seasonal appearance. Some are more abundant one season than another and some may continue longer than others when they do appear. As certain species are specific germ carriers, it is essential that the seasons of different species be carefully studied and tabulated.

Tenth.—We have not found that any species of mosquito will deposit eggs upon anything other than water. Even with *C. sollicitans*, under a variety of conditions, we have not been able to in any way corroborate Dr. John B. Smith's supposition that *C. sollicitans* lay eggs upon marsh grass. The possible explanation is that the eggs of this species are frequently left high and dry by the receding or evaporation of the water upon which they are deposited.

SOME OBSERVATIONS UPON TWO SPECIES OF PSOROPHORA.

The summer of 1902 produced many unusual conditions for the development of those aquatic insects that are dependent upon small ponds or pools for their perpetuation, and also gave adequate opportunity for the study of the adaptability of such forms in overcoming what are regarded as unfavorable environments. Certain sylvan mosquitoes were observed to become very numerous in a few days after heavy showers, even though a drought of three months prevailed previous to the rains. Prominent among the mosquitoes observed were two species of "gallinipper" (*Psorophora ciliata* and *P. howardii*). The natural conclusion to be drawn was that the eggs of these species, as well as of *Conchyliaetes musicus*, which was invariably found with them, lay unbatched upon the ground during this prolonged dry spell. Hence several *Psorophora* breeding places were carefully watched, and when rain fell in sufficient quantity to fill the ponds under observation larvæ could always be found a few hours after. Our investigations were continued. The conclusion was reached that all of the eggs did not hatch with the first rainfall, but that the alternation of dry and wet weather finally hatched all the eggs that had been deposited the pre-

vious season. In one instance after the first rain (following a three months' dry spell), which occurred on Tuesday at 11 a. m., adults were appearing from the pond on the following Sunday at 2 p. m. Adults were captured and caged to secure the eggs, if possible. This we succeeded in doing. In one case we kept a *P. howardii* female thirty-eight days, during which time she oviposited five times. Several specimens of *P. ciliata* and *P. howardii* were kept thirty to thirty-two days, with three and four ovipositions.

During the month of August it was not uncommon to have larvæ pupate in four days after hatching, and in one case only nineteen hours elapsed after pupation before the adult emerged. In summer, however, the normal pupal life is from twenty-four to thirty-three hours. During November the larval and pupal life is more prolonged. Eggs deposited in August and September have not hatched up to the present time, and are now likely to remain in this condition until next summer.

SOME INSECT INHABITANTS OF THE STEMS OF *ELYMUS* *CANADENSIS*.

By F. M. WEBSTER, *Urbana, Ill.*

While studying the *Isosoma* infesting the stems of grains and grasses in connection with some investigations carried out for the Division of Entomology, under Dr. Howard, I have found *Elymus canadensis*, to all appearances, unusually attractive to insect life. As will be observed from the accompanying list, several new forms have been found. Another interesting feature of the matter is that, though often *Elymus canadensis* and *E. virginicus* have been found growing interjacent, not infrequently touching each other, yet the partiality of insects for the former species is strongly indicated in the list. Species marked with a star (*) were reared also from *Elymus virginicus*. Unless otherwise stated, the stems from which the species given was reared were from the vicinity of Champaign and Urbana, Ill.

Isosoma sp. Larvæ living in the stems.

Isosoma sp. Larvæ living in cells in the stems.

Eurytoma sp. nov.? Adults August 15 to 25.

**Eupelmus allynii* French.

**Merisus isosomatis* Riley.

Homoporus chalcidophagus Walsh.

Catolaccus sp.?

Coccophagus sp.? Princeton, Ind.

**Parapteromalus isosomatis* Ashmead MS. nov. gen. et sp. Parasitic on the cell inhabiting *Isosoma*. Urbana, Ill., and Princeton, Ind.

Coccidencyrtrus flavus Ashmead MS. nov. sp. Princeton, Ind.

**Oligosita americana* Ashmead MS. nov. sp. Also reared from same species of grasses from Princeton, Ind., and in connection with *Eurytomocharis eragrostidis* Howard, at Urbana. This is the first time this genus has been recorded in America.

Elasmus websteri Ashmead MS. nov. sp. I am not certain whether this came from the stems of *Elymus canadensis* or from wheat stubble, but in either case it is from Princeton, Ind.

Xanthoencyrtus nigroclavus Ashmead MS. nov. gen. et sp. Princeton, Ind.

Elipsocus sp.? One of the Psocids.

Fora n. sp.? A root louse closely allied to if not identical with one found also about Urbana, Ill., on the roots of cheat, *Bromus striatus*, in July.

**Brachytarsus alternatus* Say. One individual from stems collected near Champaign, Ill.

**Cathartus advena* Waltl. This was reared in considerable numbers from stems of both *E. canadensis* and *E. virginicus* collected in various localities in Illinois and Indiana. Just what the larvæ feed upon is not clear, as the stems in all cases were stripped of leaves and the heads were invariably removed, leaving only the bare stems with, in some cases, the enveloping sheath.

Besides the foregoing a Coccid occurred quite commonly under the enveloping sheaths and the larvæ of some species of Lepidoptera were frequently to be found. I failed to rear the moth from these larvæ, but they feed within the stems, not infrequently gnawing out the center of the joints so that the stem is hollow from bottom to top.

It must be stated in connection with this list of the insect inhabitants of this species of grass that I have made no attempt at an exhaustive study. The prime object in collecting the stems from several and widely separated localities was for the purpose of studying the species of *Isosoma* infesting them. *Elymus* appears to be unusually attractive to these insects, but I have invariably found the larvæ vastly more numerous in *E. canadensis* than in *E. virginicus*. This might afford the basis for a discussion of the question as to which of the two species of grass was the older; but, in the language of Kipling, "that is another story." I have little doubt that a further and more extended research will develop a still greater number of insect inhabitants of this grass, and the fact that the new genera and species brought to light may be considered in this case as a sort of by-product from the study of the *Isosomas*, ought at least give zest to a further study in other localities.

SOME INSECT NOTES OF THE YEAR.

By F. M. WEBSTER, Urbana, Ill.

In going about in several States of the Middle West, one of the most striking features of insect attack observed out of the ordinary was the great number of leaves of plants and grasses that had been attacked by leaf miners, seemingly for the most part belonging to several species of Diptera, though, as I failed to rear anything but great numbers of parasites from affected leaves, it is of course impossible to give definite information relative to the host insect. Verbena plants brought from Ohio in June and planted in the open in Urbana were

so completely leaf-mined as to render them worthless. From leaf-mined blades of *Panicum proliferum* I reared myriads of *Pedobius websteri* Ashmead, MS. The whitened tips of the leaves of the *Panicum* were so numerous along the streets of Urbana, Ill., as to render them conspicuous objects.

Many years ago, at Oxford, Ind., I reared *Eumetopia rufipes* Macq. from the stems of *Panicum crus-galli*. The larvæ were first observed at work in the stems in June, others again in August, the adults appearing August 13. The effect on the stem of the grass is much like that of *Meromyza americana* on wheat, except that the grass is attacked before as well as after heading, the attack being to the upper portion of the stem. I was not then able to get the flies identified, and no report was ever made of the rearing.

Ceratonia catalpæ Edw. attacks the catalpa trees in southern Indiana and Ohio, sometimes completely defoliating them. The larvæ are attacked by Tachinid flies, and the larger portion of them seemed to have been parasitized in this way. Farmers about New Harmony, Ind., report that the cuckoo also feeds upon them.

Pseudanthrenus longulus Dietz (?) was found in the seed pods of *Menziesia pilosa*, collected in the vicinity of Marlinton, W. Va., probably in July.

Rhodothenus 13-punctatus Ill. was observed feeding on the half-ripe seeds of the garden sunflower, August 16, 1902. I had previously reared the adult beetle from larva found burrowing in the stalk.

Schizocerus zabriskei Ashm., adults of which were observed in Illinois and Indiana in considerable numbers, appeared to be prevented from breeding in purslane through some cause not clearly apparent, as it was rare that the work of the larvæ was to be found.

Again, I have witnessed the work of some of our Coccinellids in terminating an outbreak of aphides. In the vicinity of Princeton, Ind., late in August, I found a field of red clover that, as was clearly indicated by the appearance of the clover leaves, had been literally overrun with a species of aphid, though there were few of them left at the time of my visit. There were, however, swarms of lady beetles and their larvæ and pupæ to be found everywhere. The species most numerous were *Hippodamia 13-punctata*, *H. glacialis*, and *H. parenthesis*. The leaves of the clover were stunted, blackened, and curled with the cast skins of the aphids scattered plentifully over them.

Idolothrips coniferum Perg., both adult and larva, were found among stems of rye in July and in stems of *Elymus* in August, at Urbana, Ill.

Eurytomocharis cragrostidis How. was observed cleaning its body. To clean the head and thorax the anterior pair of feet was used, and the motions made in doing this can best be illustrated by watching a white rabbit perform the same operation to its face, the quick, jerky motions being similar in the case of each. For cleaning the wings

and abdomen the posterior pair of legs and feet was used, the same ludicrous motions being made in the operation. As illustrating the tenacity of life in this species, an individual was observed at 6.30 a. m. with abdomen, wings, and one posterior leg gone, but it continued to survive in this badly crippled condition until 9 a. m. of the same day.

Anosia pleurippus Fab. certainly migrated southward across Illinois in swarms during September. Looking out from my library window in Urbana, Ill., at 3 p. m., September 12, I saw hundreds of these butterflies winging their way hither and yon, seeming to be gathering together in the tree tops. The wind was brisk from the northwest, temperature 55° F., and the sun shining unobscured. Light frost during night of 12th, and it was not until about 9 a. m. of the 13th that the butterflies began to appear. They were, or seemed to be, flying aimlessly about, but by 10 a. m. they had all disappeared, though I was unable to witness their going, on account of other duties. Swarms of these butterflies were reported at Milledgeville, Carroll County, about 160 miles to the northwest, on the 9th, and, later, at Hoopston, to the northeast. The fact of a migration was shown by the continued occurrence of these butterflies in their usual numbers in this same locality during the rest of the month.

Aphis mali Fitch. Usually, this is not a serious pest of the apple, and in some cases it is really more of a pest of the wheat field than of the orchard. In the State experiment orchard at Orleans, in Indiana, late in October, I had an opportunity of seeing just what the pest was capable of doing among very young apple trees. At that time there were but few of the aphid on the young trees and these few were mostly confined to the tips of the twigs where these had not already been killed. In most cases, however, the little new growth that had been put forth was devoid of healthy leaves, only stunted and dried foliage and stems remaining. The rows of young trees looked as though some one had weeks before passed along with a lighted torch and scorched them, killing the new leaves and tender growth of twigs. Just what this would mean in an experimental orchard of very young trees can only be fully understood by those who have been engaged in such work.

The Hessian fly, notwithstanding its abundance in volunteer wheat, has affected only the earlier-sown wheat. All over southern Indiana and Illinois there is ample proof that September-sown wheat invites the attack of the fly, and that wheat sown in these localities after the first week of October will, as a rule, suffer little from the attack of this pest in the fall. Intelligent farmers are now watching the season as well as the fly, and timing their sowing to fit these conditions.

I do not recall that attention has been drawn to the fact that the red rust of wheat is much more liable to attack fly-infested plants in the fall than those not thus affected. In the fall of 1900 all early-sown

plats of wheat at the Ohio Agricultural Experiment Station were severely attacked by both Hessian fly and red rust, so much so that the station botanist called attention to the occurrence of rust in the wheat fields in the agricultural press. Plats sown before September 25 were all seriously affected by the rust, that sown on the 21st being much more seriously injured than the other plats, for the reason that, with the others, it was attacked by the fly, but the rust coming at the critical period of its growth prevented the plants from sending out tillers, and the damage begun by the fly was thus rendered disastrous by the rust. The present year, in southern Illinois, I also witnessed again something of the same sort, with this variation, however: Where the wheat had been sown on wheat-stubble lands, and sown early, the young plants had been attacked by the fly, and later the damage had been accentuated by the rust: and, singularly enough, the exact location of the shocks of the harvested grain of the previous crop could be clearly observed by the much more reddish appearance of the young growing grain, a fact that could be observed at a considerable distance away. In fact, a circular space the area of the old grain shock was fairly browning under the effect of the rust, which lessened in intensity from this area outward. These brown-yellow spots could be seen regularly in rows across the field as the grain had been shocked at harvest.

MOSQUITOCIDES.

By J. B. SMITH, *New Brunswick, N. J.*

It is not always possible at once or entirely to abolish breeding places for mosquitoes and it is highly desirable that we should have at command some material or class of materials that will kill larvæ or for a time make pools uninhabitable for them. There is a popular belief in the effectiveness of certain substances without any real basis, and "mosquitocides" in varying forms testify to the interest which dealers in patent nostrums are quick to discern in the public.

The most readily available of all the materials that have been used is petroleum, crude or partly or wholly refined. Sprayed over the surface of a pool, it forms a film that covers it completely and kills in a short time the larvæ or pupæ that are compelled to try for air through it. In the grade known as fuel oil, it forms a very good practical material where its odor or its general unpleasant mussiness are not objectionable. For sewer or catch basins it is probably as good a thing as can be used, and on quiet waters in confined areas where a thin film can be maintained, its odor will scarcely be offensive. On larger pools, open to the winds or interrupted by grassy or other vegetation a great deal of oil must be used, or an unbroken film, even if secured, will not last long enough to kill more than a small

proportion of the larvæ. I have several times tried the oil on road and open meadow pools when there was only a light wind blowing, to find in a few minutes all the oil film at one side and a very fair congregation of larvæ at the other. In grassy pools the tendency is for the oil to gather about the vegetation, and where there is much floating matter the spread of the oil is materially hindered if not altogether prevented.

Admitting, then, the very great range of usefulness of the petroleum, it was deemed useful to make a number of laboratory trials of other substances to determine whether it would not be possible to obtain something that would mix readily with the water, making it unfit for wrigglers to live in for some considerable period.

Materials for experimental purposes were sent in by the Phinotas Chemical Company of New York; Mr. F. B. Kilmer, president of the New Brunswick board of health, sent me a supply of chloro-naphthalam from the stock of the board, a series of other cresol preparations, and a variety of disinfectants from Johnson & Johnson. These latter samples were not of the firm's manufacture, but, rather, from the stock carried for general use. Other things were purchased as needed.

The larvæ and pupæ used for the experiments were usually obtained from a series of pails kept partly filled with water in my garden, but some were obtained from out-door pools within the city limits. The species was always *pungens*, with an occasional small admixture of *territans* or *restuans*, until in August *Anopheles punctipennis* became common enough to be added.

PERMANGANATE OF POTASH.

Six 1-quart jars were used, each containing 16 ounces of water, in which were from 50 to 100 larvæ, ranging from one-fourth to full grown. A stock solution of permanganate was made, of which 8 drops equaled 1 grain of the crystals.

Jar No. 1 received 1 grain; jar No. 2 received 2 grains; jar No. 3, 4 grains; jar No. 4, 8 grains; jar No. 5, 16 grains, and jar No. 6, 32 grains of permanganate.

In each case the water became at once distinctly discolored, and where the larger amounts were used became so deeply purplish that the liquid was opaque and the wrigglers could not be seen except at the surface. No immediate effects were observable in any jar.

After forty-eight hours all the larvæ in jar No. 1 were yet alive and active. In jar No. 2 about 20 per cent of the larvæ were alive, and these were the larger specimens that would have pupated shortly. In the jars containing the stronger mixtures all the larvæ were dead, and it is fair to say that for certain death to the larva in a reasonable time at least 4 grains of permanganate would be required in every pint

of water. At this rate 1 ounce of the permanganate would make 120 pints or 15 gallons uninhabitable for mosquito larvæ, at a cost of $1\frac{1}{2}$ cents for material.

“MOSQUITOCIDE.”

Under this name a preparation, mostly permanganate of potash, was placed upon the market. It was advertised to some extent, and claims were made which, if they were only approximately true, would solve the mosquito question at once and for all time. A small pinch was supposed to rid an ordinary lawn of all insects, and 5 pounds would keep an acre clear for an entire season. So on August 9 a small lot of larvæ and pupæ was placed in four 4-ounce bottles. As the “pinch” was the measure provided for in the directions for use, I put “pinches” of varying quantity into the bottles. The resulting color ranged from a rather clear red to a deep opaque purple. August 10 the deepest-colored liquid was so diluted as to make things visible, and it was found that, while all the larvæ were dead, all the pupæ were alive and active.

A second bottle, in which the liquid was just transparent enough to see through, had a few pupæ and quite a number of full-grown larvæ when the experiment began. August 10 the hood over the bottle was full of adults and most of the larvæ had changed to pupæ. Only a few larvæ remained, but these were very lively. August 11 adults from the last batch of pupæ began to make their appearance and the experiment was closed.

In the other bottles the larvæ developed well, and apparently paid no attention to the presence of the permanganate.

Practically these permanganate of potash preparations are of no value, and this conclusion agrees with that reached by Dr. L. O. Howard.

SALT.

Culex pungens has not been normally found in salt or even brackish water, and I do not believe that the female ever forms its egg boats on such waters. It became a matter of some interest, therefore, to determine what effect the addition of salt would have, and I transferred the contents of one of my garden pails to a 2-quart jar half filled with water. The range was from egg boats to pupæ, and after twenty-four hours the water was one mass of wrigglers, most of them small or very small. I added a small handful of common salt, dropping it through the meshes of the bobbinet hood until it formed a layer at the bottom, which dissolved completely in an hour or two. Forty-eight hours afterwards no bad effects were observed, and the larvæ appeared to enjoy the salt water immensely. I doubled the amount of salt previously used, and it formed a layer over the entire bottom of the jar and did not completely dissolve for ten hours. Twenty-four

hours later the larvæ were as lively as ever, there were no dead specimens, and adults in some number were in the hood. The conditions were allowed to continue, until it became certain that development would continue normally, and the experiment was then closed.

Another series of experiments was made beginning October 4 with "sea salt" as sold in drugstores for the bath. Four jars were used, each with 20 ounces of water, into each of which was placed 50 or more larvæ of all sizes and some pupæ. To jar No. 1 I added one thirty-second of an ounce of sea salt. October 8 this jar contained a few dead small larvæ. October 9 larvæ and pupæ were both active and developing normally. On October 10 there was no change and the experiment was closed.

To jar No. 2 I added one-sixteenth ounce of sea salt. Four days later, October 8, there were only a few dead larvæ, but 15 adults had developed meanwhile. No change taking place, the culture was closed on October 10.

To jar No. 3 I added one-eighth ounce of sea salt. October 8, four days later, there were few living larvæ left, but there were 25 adults in the hood. Next day only one live larvæ remained, and on the 10th all were dead.

To jar No. 4 I added three-sixteenths ounce of sea salt. Four days later, October 8, 34 adults had issued, and there were yet a few living larvæ. On the 10th all save a few full-grown larvæ were dead and the culture was closed.

The extreme amount of salt used was not large, but the result indicates that moderate amounts of salt placed in water would have no injurious effect upon the development of this species.

NAPHTHALINE.

Two jars were stocked with large numbers of larvæ, from the young just out of the egg to pupæ, in about 20 ounces of water. Into jar No. 1 I dropped one large ball of naphthaline and into jar No. 2 I dropped two balls of the same material. I watched developments for a week and could not find that the larvæ minded it in the least. Even the smallest made their way under and around the balls, feeding as freely as they did anywhere else in the jar.

There was no real expectation that naphthaline could be profitably used to destroy larvæ, but it is used not infrequently as a disinfectant, and if it had incidentally any effect in this direction the fact would be worth knowing.

LIME.

Eight pails are used in the garden to secure larval material for experimental purposes. They were established June 11 and kept under observation all summer; but besides *pyralis* only an occasional

territans and late in the season some *Anopheles punctipennis* developed.

In the beginning of the season the new pails seemed to offer no attraction to the insects, while last year's pails, all blackened inside, were always fully stocked from the start.

Into one of these old pails I dropped a small quantity of slaked lime, not enough to make the water milky or to cause any obvious change in its appearance. Next morning I found a thin lime scum on the surface, no living larvæ, and two new egg boats, from which no larvæ ever developed. The pail was open to sun and rain, and a week later the lime coating was gone and a new lot of young larvæ was observed.

The experiment was duplicated in one of the new pails, and for over a month the pail had no trace of larvæ. In fact, to start it at all I washed it out and added a little garden soil, with a tuft of sod and a little torn grass. That proved effective at once, and next morning there were two or three egg boats on the surface.

The use of lime may under some circumstances be very convenient and effective, especially in foul pools on dumps and in cesspools. So long as there is enough to form a scum no mosquito larva, *Culex*, or *Anopheles* can develop.

An incidental observation in this connection may prove of interest: A little keg that had contained "Calcothion," which is a ready-made lime, salt, and sulphur mixture, was left outdoors and became nearly filled with rain water. After a few days this swarmed with larvæ, which gathered their food from the lime-coated sides of the barrel and reached the pupal stage before I interfered.

COPPERAS.

Several experiments were made with this material, but the record slips were accidentally destroyed. The result was not encouraging, however, as very large quantities were required to destroy the larvæ, and I did not feel at all certain that the larvæ were not simply starved out by the destruction of their food supply.

CRUDE PETROLEUM.

The subject of the petroleum has already been touched upon and is introduced into this series only to record a small test that was made with an old oil from which the volatile parts had pretty well escaped. This was dropped on the surface of a pail of water to test its spreading power, but it remained persistently in globules and drops and for over an hour did not change at all. Then I stirred up the mixture thoroughly, breaking up the oil into fine globules, but yet it formed no film and killed only a few larvæ. After yet an hour I stirred up the whole mixture once more, and finally, six hours afterwards, all

larvæ and pupæ were dead. This is a hint that if crude oil is to be used it must not be too heavy, but must have light oils enough to enable it to spread thinly over the surface.

PHINOTAS OIL.

This material has been used in a number of places with excellent success and combines in a remarkable degree the water-poisoning quality like that of the cresol preparations, with the surface-coating effect of the light mineral oils. Dropped into water in a coarse spray it sinks to the bottom in globules which begin to dissolve, giving a milky tinge to the water around each. In a short time these globules rise to the surface, burst, and a surface coating extends in each direction from the center. The question was, how little of the material is needed to produce the effect, and to this end a number of experiments were made at different periods in the summer in fresh water and in salt. Only two laboratory tests need be referred to here.

I prepared a mother mixture of 5 cc of phinotas oil in 500 cc of water, the ratio being 1 to 100. Of this I poured 5 cc into 500 cc of water containing mosquito larvæ of all sizes, the strength of 1 to 10,000. In 5 minutes all were dead.

To another jar I added 3 cc of the mother mixture to 500 cc of water (about 1 part in 16,000) and in less than half an hour all the larvæ were dead.

The limit of practical effectiveness may be safely set at 1 part to 15,000 of water; that is, 1 gallon of phinotas oil will so poison 15,000 gallons of water as to kill all mosquito larvæ there may be in the water. It is doubtful whether any other material comes anywhere near this in effectiveness. Furthermore, the action of the material is not affected by the wind. It spreads everywhere throughout the water, and if the body be confined it remains poisoned for weeks unless added to materially.

It would seem as if we had here the ideal mosquito destroyer, and so we have for certain purposes. In sewer or catch basins or in foul or stagnant pools it would be almost impossible to find anything better. In stagnant gutters it is very useful, but the oily surface scum is objectionable. Yet in every well organized mosquito campaign this phinotas oil would seem to be indispensable.

The objection to the material is that it is too effective in undesired directions, for it kills things that it is not desirable to injure if possible. It is quite probable that it has been used in altogether too large quantities; but as used it has killed fish as well as other aquatic animals and insects, and it has been accused of killing chickens and other animals that drank of the water impregnated with it. It is also fatal to vegetable life, and any pond treated with this material in liberal quantities would be completely cleared of all animal and vegetable life, and

would become an ideal mosquito-breeding place as soon as the oil has been sufficiently diluted or carried off.

Personally I do not like the smell of petroleum, although I have worked with and recommended its use often enough, and I do not like the scum and tarry sediment on the plants and borders of pool or pond. Hence, I do not like that feature of the phinotas oil that makes for a surface coating. It is not at all necessary to help the action of the soluble portion, and it is just as liable to become imperfect as the fuel oil, which costs about one-fourth as much and acts only from the surface.

Its field is wherever it is desirable to clear any liquid of mosquito larvæ promptly and without regard to consequences. It is quite possible that some of the objectionable features would disappear or become materially lessened if no more than enough to obtain the desired result was used; but I would always advise against the use of any poisonous substance in any body of water that contains fish.

A limitation to the material is that it does not do well, if at all, in salt water. During July I tried it at Anglesea in breeding jars and in salt-water pools filled with larvæ of *C. sollicitans*. In neither case did it produce the characteristic milky appearance, although used rather in excess, and in the case of the pools there was none of that surface spread which is usually so characteristic.

These salt-water pools, treated at several places along the shore, proved rather unsatisfactory subjects, and usually I could find, twenty-four hours after treatment, nearly as many larvæ as there were the day before.

Some of the more promising materials were also used on outdoor pools, but no results different from those of the laboratory were obtained.

"PHINOTAS DISINFECTANT 20 PER CENT."

A sample of material labeled as above was reduced to a 1 to 100 stock solution, and two jars, each containing 500 cc of water, were stocked with larvæ of *Culex* and *Anopheles*.

Jar No. 1 received 5 cc of the stock at 4.45 p. m., and ten minutes later most of the *Culex* larvæ were dead. At 5.30 p. m. all pupæ, all *Anopheles* larvæ, and a few full-grown *Culex* larvæ were yet alive. At 8 a. m. next day two *Anopheles* larvæ and some pupæ were yet alive. At 12 m. only pupæ remained alive, and the record had not changed at 4 p. m., when the experiment was closed.

Jar No. 2 received 10 cc of the stock at 4.45 p. m., and ten minutes later nearly all *Culex* and the smaller *Anopheles* larvæ were dead. At 5.30 p. m. one or two *Culex* larvæ were yet feebly alive. At 8 a. m. next day several *Anopheles* larvæ and several pupæ were yet alive, though all larvæ were dead. No adults emerged in either jar.

“PHINOTAS DISINFECTANT 5 PER CENT.”

The sample was reduced to the stock solution of 1 to 100, and a jar with 500 cc of water was stocked with larvæ and pupæ of *Culex* and *Anopheles*. At 9.25 a. m. I added 5 cc of the stock solution. At 10.10 a. m. the *Culex* larvæ were dead; at 10.30 the *Anopheles* began to die, and all were dead at 2 p. m. All pupæ were yet alive. Next morning 6 adults were found in the hood and 5 cc of the stock solution was added, doubling the amount in the water. Yet twenty-four hours later several adults were again in the hood and all the pupæ were alive, seeming not in the least discommoded by the disinfectant.

The difference between the action of the material on the larvæ and on the pupæ is most remarkable and, once the pupal stage was reached, development seemed not in the least interfered with.

“PHINOTAS MARK G.”

The sample was reduced to the stock solution of 1 to 100 and two jars with 500 cc of water were stocked with larvæ and pupæ of *Anopheles* and *Culex*. At 4.30 p. m. I added 5 cc of the stock solution to jar No. 1, and at 4.55 most *Culex* and some *Anopheles* larvæ were dead. At 5.30 all *Anopheles* were dead, but a few *Culex* larvæ were yet alive. Next day, at 8 a. m., a few pupæ remained alive; at 12 m. everything was dead.

To jar No. 2 I added 10 cc of the stock solution at 4.30 p. m. At 4.50 all *Culex* larvæ were dead; at 5.30 only pupæ remained alive; next morning everything was dead.

SOLUBLE BLAST FURNACE OIL.

I reduced the sample to the stock 1 to 100 mixture and stocked two jars, each containing 500 cc of water, with larvæ and pupæ of *Culex* and *Anopheles*. At 3.30 p. m. I added 5 cc of the stock to jar No. 1, and in twenty minutes all *Culex* larvæ were dead. At 4.40 p. m. all the larvæ were dead, and though the pupæ were alive, the adults died as they attempted to emerge.

In jar No. 2 I added 10 cc of the stock at 3.25 p. m. All larvæ were dead in five minutes; but at 5.30 some pupæ were yet feebly alive.

Of the phinotas preparations nothing is equal in effectiveness to the “phinotas oil.” The other preparations mix fairly well with water, form no surface scum, and all impart a milky tinge to the water. The proportion where 5 cc of the stock was used is 1 to 10,000; where 10 cc was used is 1 to 5,000.

"CHLORO-NAPHTHALUM."

This is a cresol preparation readily soluble in water, used for disinfecting purposes by the New Brunswick board of health. It forms no surface scum, and turns the water milky when added in any quantity. As it was intended to make a field application to breeding pools within a certain portion of the city limits the substance was tested a little more fully than some others; but as the tests were made in early July, when no *Anopheles* larvæ were available, only larvæ and pupæ of *Culex pungens* were used.

The stock solution in this case was 1 to 200, and 6 jars each with full 10 ounces of water were used. The larvæ in each case ranged from two or three days old to full grown, and between 50 and 100 were in each jar.

Jars Nos. 1 and 2 each received stock solution to make the mixture 1 to 12,800, and at that dilution the water was faintly white tinged. After twenty minutes, 50 per cent of the larvæ were dead—mostly the smaller specimens. After two hours, 25 per cent, including all the full-grown examples, were yet alive, and eighteen hours later there had been practically no change, except that some larvæ had pupated.

Jar No. 3 received stock solution to make the mixture 1 to 6,400, and the water was appreciably white-tinged. After twenty minutes only about 10 per cent of the larvæ were alive, and in two hours only pupæ and a few full-grown larvæ remained alive. After eighteen hours a few more larvæ were dead, but pupæ remained unaffected.

Jar No. 4 received stock solution to make the mixture 1 to 3,200, which rendered the water a little translucent. Though this jar had double the amount of stock solution put into No. 3, the effect was exactly the same, and at the end of ten hours there were quite as many larvæ and all pupæ left unaffected.

Jar No. 5 received stock solution to make the mixture 1 to 1,600, and this made a decidedly milky, opaque liquid, in which all the larvæ were dead in five minutes. One pupæ survived after three hours, but was so feeble that its death was certain.

For practical work, mixtures ranging between 1 to 1,000 and 1 to 1,500 will prove fatal to larval life—that is, to a body of water containing 1,000 gallons or thereabouts, 1 gallon of chloro-napthalum must be added to kill all the mosquito larvæ in it. At that strength it is also a good disinfectant, and its use in gutters and on dumps is cleansing and the effects are lasting.

Pools in which mosquitoes bred in the Sixth ward, in New Brunswick, were twice treated during the summer with this material and in each case the larvæ were killed off and the pools remained free until flooded by heavy rains. The effect on the local mosquito supply was quite marked. The manner of application was to pour a gallon of the

disinfectant into 50 gallons of water, stir thoroughly and apply to pools and gutters with a sprinkler. Sewer catch basins were not treated because it was not realized until late in the season how many of the insects bred in such places.

“PURALINE.”

This is a preparation similar to the preceding, but much cheaper, and is also used as a disinfectant. It dissolves in water in the same way and produces a milky mixture. Cresol is the active base.

Several mixtures more dilute than 1 to 10,000 were tried, and proved practically ineffective. Larvæ and pupæ of *Culex pungens* only were used. The effective mixtures were as follows:

To jar No. 1 I added from the stock solution enough to make the proportion 1 to 8,000. An hour afterwards a few larvæ and all pupæ were yet alive, but next morning everything was dead.

Jar No. 2 received stock solution to make the mixture 1 to 4,000, and an hour afterwards all larvæ and nearly all pupæ were dead.

At 1 to 4,000 this material is as effective against mosquitos as the chloro-naphthalam is at 1 to 1,000—that is, four times as effective at one-fourth the price. Its range of usefulness is as for the previous mixture.

“TAROLA.”

This preparation is from the Barrett Manufacturing Company; is also soluble in water, and produces a milky emulsion.

The usual 1 to 100 stock was made, and 5 cc was added to 500 cc of water containing larvæ and pupæ of *Culex* and *Anopheles*, at 10.40 a. m. An hour later most of the *Culex* larvæ were dead. At 3.15 p. m. a few more pupæ were dead. Next day at 8 a. m. no more pupæ had died, and I added 10 cc from the stock, making the mixture 1 to 2,500; but at 11 a. m. many pupæ were yet alive.

The remarkable resistance of the pupæ to preparations of this character is quite noticeable, and at 1 to 2,500 it was not really more effective than at 1 to 5,000.

“MILKY DISINFECTANT.”

This is another of the preparations of the Barrett Manufacturing Company, and produces the same milky emulsion.

The usual 1 to 100 stock was prepared, and at 8 a. m. 5 cc was added to 500 cc of water containing larvæ and pupæ of *Anopheles* and *Culex*. An hour later all the larvæ were dead. At 10.30, as no pupæ were dying, I added 5 cc from the stock solution. At 3.15 p. m., no change being noted, I added 5 cc additional from the stock, and at 5.45 p. m. a few pupæ were dead. At 8 a. m. of the day following some pupæ

were yet alive, but no adults had issued. I added 10 cc from the stock and in a few minutes all the pupæ were dead.

In other words, a mixture of 1 to 10,000 will kill larvæ, but it requires one 5 times as strong to kill pupæ.

“CRETOL, HASSLIGER NO. 1.”

This is one of the preparations sent me by Mr. F. B. Kilmer, president of the New Brunswick board of health, and it was tested on the larvæ and pupæ of *Culex pungens* only.

At a dilution of 1 to 8,000 it killed all the larvæ in a few minutes and all the pupæ in an hour.

“CRETOL, HASSLIGER NO. 2.”

This material is not so readily soluble as the No. 1 and forms an oily or tarry surface film. I made the usual stock of 1 to 100 and tried it on *Culex pungens* only. I added 5 cc of the stock to 500 cc of water containing larvæ and pupæ, and in a few minutes all larvæ were dead; in half an hour the pupæ also had succumbed.

Both of these preparations are very fatal to pupæ compared with some of the others previously reported.

SOLUBLE CREOSOTE.

This also was sent me by Mr. Kilmer. It mixed readily with water, forming the usual milky emulsion, and was reduced to the usual stock, 1 to 100. It was used on *Culex pungens* only in jars containing 500 cc of water.

To jar No. 1 I added 5 cc of stock at 10.30 a. m. At 2.45 p. m. many larvæ were yet alive, all pupæ were active, and many adults had issued. It was only upon young larvæ that this mixture had any ill effects.

To jar No. 2 I added 10 cc of stock at 10.30 a. m. At 2.45 p. m. all larvæ and some pupæ were dead, while one adult had emerged. No more adults emerged later, and all pupæ were dead next morning. At 1 to 5,000, therefore, soluble creosote is a good larvicide.

“CRESOL, 100 PER CENT.”

This is one of the materials referred to as coming from the stock of Johnson & Johnson, but is not a product of their manufacture. All their samples mixed readily with water, and were purer grade materials than any of the preceding.

I reduced the cresol to 1 to 100 and added 5 cc to 500 cc of water containing larvæ and pupæ of *Culex pungens*. Eighteen hours later only the small larvæ were affected: some of the mature larvæ had

pupated and some of the pupæ had transformed to adults. I added 10 cc from the stock, but when, three hours later, no additional effect was noted, the experiment was closed.

“PHENOL-SEPTOL.”

The usual 1 to 100 stock was prepared and 5 cc was added to 500 cc of water containing larvæ and pupæ of *Culex pungens*. Two days later nothing had been killed and many adults had issued. I added 10 cc from the stock, and when, two hours later, no added effects were noticeable, added 10 cc more. After waiting yet twenty-four hours and when nothing had been killed, I considered myself fairly entitled to class this as a harmless material.

“SYNOL LIQUID.”

This is one of the materials entering into the preparation of synol soap, and it was reduced to the usual stock solution.

To jar No. 1 was added 5 cc to 500 cc of water containing larvæ and pupæ of *Culex pungens*, at 9.45 a. m. At 12 m., no effect appearing, I added 15 cc of stock, which killed some larvæ by 5 p. m.

To jar No. 2 was added 10 cc to 500 cc of water as above. At noon no bad effects were noticeable on the larvæ. At 1.20 p. m. I added 30 cc of stock, and at 5 p. m. only one pupa remained alive.

This is not a reliable larvicide, and is as expensive as it is ineffective.

“SAMPLE C., J. & J.”

This was reduced to the usual stock of 1 to 100, and at 8 a. m. 5 cc was added to 500 cc of water containing larvæ and pupæ of *Culex* and *Anopheles*. At 10.30 adults began to issue and, as neither larvæ nor pupæ seemed affected, I added 5 cc from the stock. At 1 p. m. nearly all *Culex* and some *Anopheles* larvæ were dead. Next morning all pupæ were yet alive and several adults had issued. I then added 20 cc from the stock, but three hours later not even one more pupa had died and the culture was closed.

“SAMPLE T., J. & J.”

This was reduced to the usual stock solution, 1 to 100, and 5 cc was added to 500 cc of water containing larvæ and pupæ of *Culex* and *Anopheles*. No effect being apparent three hours later, I added 15 cc from the stock, which killed all larvæ in one and one-half hours. Twelve hours later everything was dead.

In another jar I added 10 c. c. of the stock, and all save a few mature larvæ were dead in five hours. Twenty-four hours later a few of the larvæ and all the pupæ were yet alive.

It appears as the result of these experiments that there are several preparations that will serve both as disinfectants and larvicides even when highly diluted. In almost every city and town there are foul or imperfect gutters where water lies, and sewer or other catch-basins, always containing water and only flushed by occasional heavy rains. These could be treated by the local boards of health in their ordinary process at very small expense. So rain pools in vacant lots could be temporarily made harmless until the owner had been compelled to either fill or drain them. Judiciously used, even a barrel of such material as "Puraline" would keep a large area clear of breeding places, while if an equal amount of Phinotas oil were added and used where it could be safely done, the area could be much more than doubled. Cesspools would stand the same sort of treatment, but cisterns and water barrels could not receive anything that might render them dangerous to life or health. But these can be reached in an entirely different and equally effective way, as is elsewhere shown.

DISTRIBUTION OF THE SALT MARSH MOSQUITO IN NEW JERSEY.

By J. B. SMITH, *New Brunswick, N. J.*

[Withdrawn for publication elsewhere.]

THE PERIODICAL CICADA (*Cicada septendecim* Linn).

By J. B. SMITH, *New Brunswick, N. J.*

[Withdrawn for publication elsewhere.]

VERNACULAR NAMES OF INSECTS.

By EDWIN W. DORAN, *Champaign, Ill.*

The subject of vernacular names of insects has been discussed briefly before this body on two former occasions, but otherwise scant attention has been given it and the discussions mentioned seem to have been barren of direct results. In 1897 Prof. C. P. Gillette presented a paper before this association on vernacular names and included in his paper a list of about fifty species written in accordance with his views. At the next meeting of the association the writer presented a brief discussion of the matter and suggested certain corrections in Professor Gillette's list.

I know of nothing else which has been published on the subject except an article which I published in *Entomological News* for November, 1902. The matter seems worthy of further consideration. Every

one must have noticed the utter confusion which prevails among entomologists as to the correct form in which to write many of the names of the commonest insects, especially as to the proper compounding of these names. Some writers seem to have an antipathy for the little character called a hyphen, and avoid the use of it on all occasions.

Nevertheless there is a place for the hyphen, and most entomologists use it far too sparingly, while many others use it without due consideration of the principles that underlie the compounding of English words. In the study of this subject and in the preparation of a list of 3,500 of the compound vernacular names of insects, I have worked out a system of simple rules, easy of application, yet in accordance with language principles and the usages of the highest authorities.

While it is not easy to present a subject like this before an audience, still I think it can be made so plain that I submit some rules and principles for guidance in the compounding of insect names, together with numerous illustrations of their application.

We may start with this general principle, taken from the Standard Dictionary: "*Abnormal association of words generally indicates unification in sense, and hence compounding in form.*" From this principle we derive the following rules, the first one being general, the succeeding ones more specific:

Write in compound form—

1. Any pair of names or words in joint arbitrary use.

Examples: Currant-borer, leaf-roller, walking-stick.

2. A general name used with any other name prefixed for specification denoting (*a*) food-plant, (*b*) host, or (*c*) prey.

Examples:

a. Food-plant: Apple-louse, cabbage-worm, fruit-worm, onion-thrips, potato-beetle, plum-curculio.

b. Host: Dog-flea, horse-fly, ox-warble, turkey-gnat.

c. Prey: Ant-lion, bee-hawk, mosquito-hawk.

3. A general name used with any other names prefixed for specification denoting (*a*) similarity, (*b*) habit, (*c*) habitat, (*d*) characteristic.

Examples:

a. Similarity: Buffalo-gnat, comma-butterfly, ichneumon-fly, lady-bird, mole-cricket, zebra-caterpillar, walking-stick.

b. Habit: Army-worm, burying-beetle, cut-worm, flea-beetle, kissing-bug, measuring-worm, migratory-locust, soldier-bug, saw-fly (or sawfly), tent-caterpillar, tumble-bug, web-worm.

c. Habitat: Ground-beetle, house-fly, tree-cricket, tree-hopper, water-boatman.

d. Characteristic: Blister-beetle, bot-fly, canker-worm, gall-fly, scale-insect.

4. A phrase consisting of an adjective and a noun used as a mere name should be generally written as one word.

Examples: Bluebottle, clearwing, grayback, longsting, orangetip.

Many insect names are formed in accordance with two or more rules. Examples: Apple-tree tent-caterpillar (1, 3b), nine-spotted ladybird (1, 3a), blood-sucking cone-nose (3b, 3a), case-making clothes-moth (3b, 2a), East-Indian meal-moth (1, 2a), sooty corn-root web-worm (1, 3b).

As to whether a compound name should be written as one word or with the hyphen, it is difficult to determine, as it is difficult to construct definite rules for governing such cases. Old and very familiar names like ladybird, cutworm, and bedbug are generally written as single words, while newer words like cone-nose and kissing-bug are hyphenized; but age and familiarity alone can not determine. Some very old forms are still hyphenized and probably always will be, while some newer forms are written as single words. Space will not allow here a full discussion of this part of the subject.

There is also a negative phase to this question; that is, When should the parts of a name not be united? For present purposes it is sufficient to give two general principles, quoted from the Standard Dictionary:

1. All words should be separate when used in regular grammatical construction, unless they are jointly applied in some arbitrary way.

2. No expression in the language should ever be changed from two or more words into one (either hyphenized or solid) without change of sense.

From the preceding discussion two things ought to be apparent to all: First. That the subject is worthy of further consideration; and, second, that in the main the subject lends itself readily to definite and fixed rules which are based upon established language principles. Moreover, to ignore or violate these rules and principles is as great a sin against good usage as to misspell in any other way, or to trample upon the laws of grammar and rhetoric.

One reason for the general lack of the application of principles to the compounding of insect names is that the whole subject of the compounding of English words was not reduced to a system till one or two decades ago; and those who blindly follow the ancient lack of system of Webster's Dictionary, instead of the more definite system of the Standard, Century, or Murray's New English Dictionary, are likely still to be a law unto themselves, but a law founded upon no fixed principles of the English language.

The writer hopes further to elucidate the subject of vernacular names by publishing an extensive list of the names of insects along with a complete list of the vernacular names of mammals, birds, and

other groups of higher animals, together with a discussion of the rules and principles which govern in the formation of compound names of animals.

In closing allow me to suggest the appointment of a committee by this body to whom the whole subject of vernacular names of insects shall be referred and reported on one year hence.

NOTES ON THE LARGER SUGAR-BEET LEAF-BEETLE.

(*Monoxia puncticollis* Say.)

By F. H. CHITTENDEN, Washington, D. C.

Since the publication of a note by the writer in Bulletin No. 18 of the present series, page 95, we have obtained additional specimens of this leaf-beetle, together with an account of its injuries in Colorado.

During May, 1902, living beetles were received with report that the species was destroying young beet plants at Rockyford, Colo. Our correspondent, Mr. W. K. Winterhalter, who furnished this information, stated May 7 that where the beetles had appeared they kept the leaves eaten down to a stage where the beet was unable to make any growth. They were most numerous on very warm, loose land, rich in lime, and a rapid increase under the then favorable climatic conditions was anticipated. They were quite gregarious, occurring "in swarms like blister beetles." May 24 our correspondent again sent beetles, with eggs and half-grown larvæ, stating that while the beetles had not done extensive damage they had prevented beets from growing in quite a few fields through their continual inroads on the foliage. In one instance 5 acres had to be replanted. After the beets were irrigated they grew more rapidly and thus kept ahead of the beetles, and serious damage was apparently averted for that season.

The receipt of this material enabled a study of the egg and larva, and the following descriptions of the stages, except the pupa, which is as yet unknown, are presented:

The eggs are rounded oval, somewhat variable in form, but averaging about 0.9 mm. in length and 0.7 mm. in width. They are strongly convex above and moderately flattened where attached to leaves. In the egg masses received there was an average of about 20 eggs in each cluster. They were deposited closely together, as shown in figure 3, *b*. The color of the individual egg is dull brownish gray, and the areas as seen through a lens are strongly indicated, a septagonal arrangement predominating, although hexagons also occur. It will be noted that although this species is related to the imported elm leaf-beetle (*Galerucella luteola*), the eggs and their manner of deposit is decidedly different, those of the latter insect being placed on end.

The larva (fig. 3, *c*, *d*) resembles, in general contour, both as seen from above and from the side, that of the elm leaf-beetle, but here the superficial resemblance ends, as this species is nearly uniform dark olive brown in color and the piliferous tubercles are rather pale yellow, but strongly marked. They are arranged as shown in the illustration, those of the anterior half of each segment coalescing near the center. The head is moderately shining black and portions of the legs are of the same color. The hairs are of two kinds, pointed and truncate, and some are pale and some dark in color, all being rather short. The head is about half as wide as the first thoracic segment and the body gradually tapers till the third or fourth abdominal segment when it is widened, tapering again toward the anal extremity, the last segment being quite narrow. The segmentation is strongly marked, the tubercles on the sides prominent.

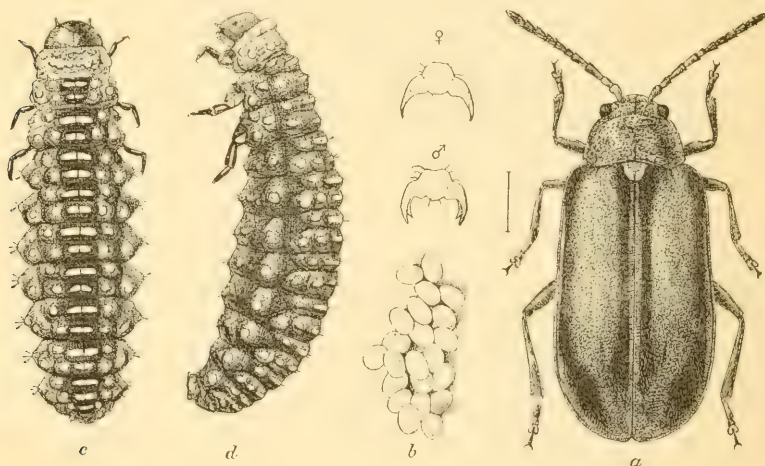


FIG. 3.—*Monoxia puncticollis*: *a*, female beetle; *b*, eggs; *c*, larva, dorsal view; *d*, larva, lateral view; ♂, claw of male; ♀, claw of female—all much enlarged, male and female claws more enlarged (original).

The length in somewhat contracted natural position is about 8.5–9.03 mm. and the greatest width 2.8–3.0 mm.

The young larva when hatched measures about 1.5 mm, and differs from the mature form in having a more prominent head, dark brown thoracic shield, and in being of a dull gray color, the tuberculous areas showing as darker brown. The legs are more prominent, and the hairs are relatively longer.

Thus far injuries by this species have been reported only from Colorado and New Mexico, and only to sugar beet. The species as defined by Horn includes four or more varieties. The typical form is the one under consideration. It is one of the larger ones, measuring five or six sixteenths of an inch in length; is dull grayish brown in color, with dull blackish stripes on the elytra, present in all individuals

examined near the exterior margin, while others show indication of more or less striation near the sutures, as shown in figure 3 *a*. The species differs from others of the same genus in having the fifth joint of the antennæ nearly one-third shorter than the fourth, and usually just perceptibly shorter than the sixth.^a To facilitate further recognition of the particular form under discussion, it should be said that the elytra are very finely and densely punctured, and pubescence is scarcely evident save at the apices. The head is more coarsely punctate, and the thorax still more deeply and roughly punctured.

REMEDIES.

Unless remedial measures are instituted, there is probability of this species becoming an important enemy of sugar-beet culture in the United States. Paris green or arsenate of lead applied in the form of a spray is all that is necessary to destroy it, and where irrigation can be practiced this enables the plants to recuperate from moderate attack.

SOME INSECTS RECENTLY INJURIOUS TO TRUCK CROPS.

By F. H. CHITTENDEN, *Washington, D. C.*

THE FALL ARMY WORM (*Lophygna frugiperda* S. & A.).—September 8, 1902, Mr. L. Donner, Seabrook, S. C., sent a series of this species in different stages of larval growth, with report that some time earlier it had done considerable damage, and had virtually stripped asparagus plants of their foliage and eaten the skin off the stalks. His asparagus plants had been sprayed ten times with the Bordeaux-resin mixture, beginning immediately after the crop and applying the spray at intervals of two weeks and after rains. But in spite of this the fall army worm ate the foliage clean, and in some parts of the plantation even peeled the stumps.

WHITE GRUBS (*Lechnosterna* sp.).—June 2, 1900, Miss Eliza A. Blunt, New Russia, N. Y., stated that white grubs did great damage to asparagus as well as grasses. An asparagus bed that was planted the previous year with two-year-old roots 3 feet below the surface showed that the grubs worked at that depth, as not a sprout had appeared during the season of writing.

THE SOUTHERN LEAF-FOOTED PLANT-BUG (*Leptoglossus phyllopus* Linn.).—September 8, 1902, Mr. L. Donner, Seabrook, S. C., sent

^a It should be stated at this point that the genus *Monoxia* is separated from *Galerucella*, with which it was formerly united, by a sexual character, which consists in the male having the claws nearly bifid; see fig. 3 ♂. In *Galerucella* both sexes are as shown at ♀.

numerous specimens of this species, with information that they were very abundant on asparagus plants nearly all summer. He had also found the bugs and their young on cowpea. The same species was reported on asparagus in South Carolina in 1897 (Bul. 10, n. s., p. 62).

A note furnished by Mr. F. W. Thurow, Harvester, Tex., is of interest. May 26, 1900, he reported finding this insect in considerable abundance on Irish potato and that it appeared to be "stinging" the plants, causing the parts attacked to wither. July 1 our correspondent sent adults and nymphs in next to the last stage, and stated that after the potatoes were dug up the insects took to a clump of spring wheat as well as to a large bush of prince's feather (*Polygonum orientale*), which latter was threatened with its life until rescued. The potato is a known food plant of this plant-bug, but wheat and *Polygonum* do not appear to have been previously observed.

It has been noticed by the writer that this species has the same habit as its congener *L. oppositus* of hiding when in the nymph stage in the folded or wilting leaves of its food plants, shedding its skin usually in such sheltered locations. A summary of food and other habits of this species has been given on pages 46-48 of Bulletin No. 19 of this series.

THE TWO-SPOTTED BLISTER BEETLE (*Macrobasis albida* Say.).—Blister beetles of several species were prominent as vegetable pests during the season and from among the many reported instances of injury and attack to useful plants a few examples of new food habits that have been unrecorded will be noticed.

July 15, 1902, Mr. S. E. Russell, Duncan, Ind. T., reported that this species was eating garden vegetables and had devoured his stock of sugar beet in a single day.

We have many earlier records of injury by this species which do not appear to have been published. In 1882 it was destructive to tomatoes, and also fed on *Solanum elaeagnifolium* at Corpus Christi, Tex. The following year it injured potatoes at Gonzales, Tex. In 1892 injuries were noticed to potatoes and peas at Stowell, Hamilton County, Kans. In 1896 it was troublesome at Alice, Tex., where it was described by Dr. J. D. Westerveldt, jr., as a migratory species coming in swarms of thousands, remaining a few days, and disappearing very quickly. In 1897 it was again destructive to potato at Kearney, Kans. The following year it devoured the foliage of tomato at Fruitland, Tex. The occurrence of the insect has also been reported at Georgetown, N. Mex., as well as in other localities in the States that have previously been mentioned. Injury at Gonzales, Tex., was noted as early as June 14, but the principal damage appears to be accomplished in that State through the month of July and the first part of August. In Kansas injury extends also through the month of August.

THE BLACK-STRIPED BLISTER BEETLE (*Macrobasis atririttata* Lec.).—August 6, 1902, Mr. J. M. Johnson, Cottage Grove, Ind., reported injury by this species to tomato and cucumber in that vicinity. We have an earlier note on its occurrence in Texas on various plants (Insect Life, Vol. IV, p. 395), but with no specific mention of the particular plants affected.

THE IMMACULATE BLISTER BEETLE (*Macrobasis immaculata* Say).—During June and July, 1902, Mr. W. K. Winterhalter, Rockyford, Colo., reported the occurrence of this species quite frequently during the year on potato, tomato, and sugar beet. July 7 it was increasing in alarming numbers, and was rapidly doing away with the potato crop. He had tried without success in every possible way to drive the beetles from the fields in which they were present by thousands. They also occurred in practically every beet patch in the valley, and while they did not destroy the beets, owing to the rapid growth of the plants, they were stripping them badly. A spray of one pound of Paris green and the same of lime to 45 gallons of water was tried without success.

This species has not hitherto been recorded as a beet insect. In fact, little or nothing appears to have been published in regard to its food habits. We have, however, an earlier record of injury, received July 17, 1897, when it was reported to be destroying beets as well as cabbage and tomato in the vicinity of Coats, Pratt County, Kans.

THE THREE-LINED BLISTER BEETLE (*Epicauta lemniscata* Fab.).—Mr. P. J. Schuur, Miami, Fla., writing of this species October 11, 1902, stated that it attacked beets, tomato, eggplant, turnip, cabbage, potato, sweet potato, and cowpea, and that it rejected onions and celery after tasting them. Another plant, okra, was not eaten, because the leaves were too high for the beetles to readily reach. Low plants were preferred, the beetles usually remaining in the shade during the heat of the day. Beet tops were the favorite food and preferred to other vegetables. A number of the food plants above mentioned have not been recorded for this species.

It seemed impossible to drive the blister beetles, but our correspondent got rid of them by means of boiling water. Another correspondent, in Texas, reported success with hot water as a remedy for the same species in 1892. Several "millions" noticed on cut pea vines disappeared overnight while preparations were being made for their destruction.

THE LEAN BLISTER BEETLE (*Epicauta strigosa* Gyll.).—June 24, 1902, Mr. C. W. Steele, editor Florida Agriculturist, Switzerland, Fla., wrote that this species was very destructive to ornamental Hibiscus by eating the blossoms, beginning first upon the anthers and pollen, and then destroying the entire substance of the petals. As many as a dozen beetles could be picked from a single flower. They were also destroying blossoms of Zephyranthes and Cooperia.

This is a common species in the South and a familiar object from its occurrence on the blossoms of cotton. It is, however, not known to injure this last-mentioned crop.

NUTTALL'S BLISTER BEETLE (*Cantharis nuttalli* Say).—July 21, 1902, Prof. L. R. Waldron, Agricultural College, North Dakota, sent specimens of this beetle, with report that it was injuring oats and barley at Minot, in that State, and attacking plants about 6 inches above ground.

THE CHANGA OR PORTO RICO MOLE CRICKET (*Scapteriscus didactylus* Latr.).—Several forms of crickets, more especially the large fossorial mole crickets, were prominent as garden pests during the past year. Of these, the above-mentioned species (fig. 4) was most con-

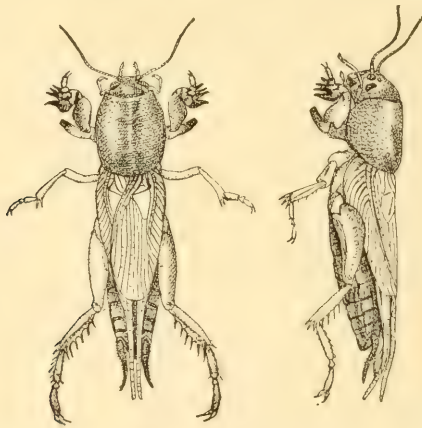


FIG. 4.—*Scapteriscus didactylus*: adult, somewhat enlarged (reengraved).

spicuous. It was described, in fact, as by far the most serious insect pest that the Porto Rican agriculturist had to encounter. January 21, 1903, Mr. S. W. Goodyear wrote in regard to the occurrence of this species in Brunswick and Glynn counties, Ga. In that region it was commonly known as the "ground puppy," a somewhat appropriate name considering its peculiarly tawny, puppy-like appearance. These insects burrow into the earth and are quite destructive to different forms of vegetation, and especially to cabbage, collard, and kindred cruciferous plants. They were unknown in that vicinity until about 1899, but since then they had caused all who raised vegetables much annoyance and considerable loss of money.

This appears to be the first report of this species doing damage to useful plants in the United States; indeed we have at present no available record of the insect's previous occurrence in the State of Georgia.

This mole cricket has been given considerable attention during the past year by Mr. O. W. Barrett, entomologist and botanist of the

Porto Rico Agricultural Experiment Station, and a 20-page publication has been issued as Bulletin No. 2 of that station, in which various remedies are duly recommended and discussed. Like others of its kind, it is subterranean and nocturnal, feeds largely on the roots of plants, and extends its depredations over the entire year.

As to remedies, clean cultivation, "hilling up," winter and spring plowing, trap lights, and poisoned baits are the best that are recommended. Mr. Barrett's bulletin can be obtained by application to the Secretary of Agriculture, and it is not necessary to make further mention of remedies here.

THE SOUTHERN SHORT-WINGED MOLE CRICKET (*Scapteriscus abbreviatus* Scud.).—During November and December, 1902, we had correspondence in regard to this species with Mr. J. A. McCrory, Miami, Fla. It was described as eating all fruits that fall to or touch the

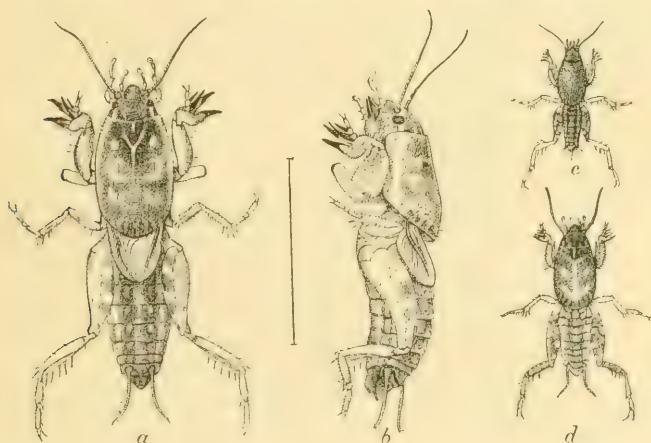


FIG. 5.—*Scapteriscus abbreviatus*; a, winged adult, dorsal view; b, same, lateral view; c, young nymph; d, older nymph—somewhat enlarged (original).

earth, and injuring all kinds of vegetables as well as seeds, including Irish potatoes, sweet potatoes, beans, and tomatoes; also as eating dried blood and ground bone in commercial fertilizer. Whole fields of tomatoes were devastated, and the insect even gnawed the roots of orange trees. Young tomato plants were gnawed off as fast as set out, and the insects were described as working up the earth like thousands of chickens scratching it. Injury began when the crickets were "no larger than a flea." They were more numerous along the Miami River and more or less scattered over the southern portion of Dade County, and were multiplying rapidly. Our correspondent stated that it was almost impossible to grow a crop of any kind on account of the destructiveness of this pest. Seed beans were devoured as soon as they became soft after planting. Of 100,000 tomato seeds scarcely one had come up on account of the ravages of these insects.

As soon as a furrow was plowed and the fertilizer and seed distributed, the crickets started in the furrow on a mission of despoliation.

This mole cricket is common to South America and the Gulf region. It was first described by Scudder^a in 1869 from Pernambuco, Brazil. From all other species of its genus that were known at that time, also inhabitants of South and Central America, this is distinguished by its very short tegmina or outer wings, hence the name *abbreviatus*. Its general appearance is shown, enlarged, at figure 5, *a*, *b*, for comparison with the Porto Rico form (fig. 4). It is one of the darker species, the thorax being brownish fuscous and ornamented with paler fulvous about as shown in the illustration. It is somewhat variable in length, but appears to average about an inch.

As to remedies, it seems probable that those which have been found most successful against the Porto Rican mole cricket are applicable, with the possible exception of lights, as the short-winged species is incapable of flight. A mixture of cotton-seed meal and Paris green was tried by Mr. McCrory, which checked the insects somewhat but not sufficiently to stop their depredations.

THE MINUTE FALSE CHINCH BUG (*Nysius minutus* Uhl.)—July 12, 1902, Mr. W. K. Winterhalter, Rockyford, Colo., wrote that this species destroyed almost half of the beet-seed crop of the company of which he is agricultural superintendent, during 1901; the injury being accomplished by the insect sapping the green seed, which in consequence dried up and became black before maturity. In 1902 this same pest bred in seed-beet fields, but the precaution had been taken of planting a few rounds of yellow mustard as a trap crop, which proved excellent, as all of the bugs lived on the mustard until it was entirely gone. After this, however, they turned to the beet seed, and at the time of writing were doing tremendous damage. The only drawback to the mustard is that it becomes a weed as soon as the seed drops on the ground.

Mr. D. V. Burrell, of the same locality, reported similar injury due to this insect, stating that it was found in large numbers the previous season on table beets grown for seed; but after flooding the part that was attacked thoroughly, and repeating in two days, he found that all the insects left the field.

A NEW PLANT-BUG ENEMY TO TOMATO AND LETTUCE.—September 6, 1900, Mr. Samuel Cliff, Creston, Cal., sent specimens of a plant-bug, *Corizus hyalinus* Fab., in different stages, with report that the insect was very destructive to tomato and lettuce in that vicinity. The material received included samples of the tomato plants that had been killed down and leaves of lettuce-seed stalk that the insects were working upon. There is little doubt that our correspondent is correct

^a Revision of the large, stylated, fossorial crickets, 1st Memoir Peabody Academy of Science, Salem, Mass., pp. 14, 15, Pl. I, figs. 8-20.

in his conclusions that this species is injurious, although on one occasion *C. hyalinus* was mentioned^a "among predaceous insects" as natural enemies of the fluted scale (*Icerya purchasi*).

A PLANT-BUG ATTACKING TURNIP, MUSTARD, AND SWEET POTATO.—December 1, 1902, Mr. F. W. Thurow, Harvester, Tex., sent numbers of adults and nymphs of *Nezara viridula* Linn, found attacking turnip tops and mustard greens, killing some plants or causing their leaves to turn yellow. The same bug was stated to attack sweet potato.

A MEALY-BUG ON PEANUTS.—So few insects are known as enemies of the "goober," or peanut, that the following note on the occurrence of *Dactylopius* sp. on that esculent is of interest. September 20, 1902, Mr. W. T. Hubbell, Philo, Ohio, sent specimens of peanuts taken from hills which were more or less withered when pulled up. He found a great many with cottony patches where this mealy-bug had developed. At this time most of the insects had disappeared. Some of the larger nuts were discolored, and our correspondent stated that some were so badly infested as to rot.

The SMALLER CORN STALK-BORER (*Elasmopalpus lignosellus* Zell.).—August 30, 1902, Mr. W. D. Hunter, Victoria, Tex., sent larvæ of this species, as also numerous stems of black-eyed cowpea which had been killed by it. The insect was infesting a field of 2 acres, and at that time fully 2 per cent of the plants had been killed, with the prospect that others would die shortly. September 9, 1902, Hon. G. W. Koener, commissioner of agriculture of Virginia, Richmond, Va., sent specimens of the larvæ in cowpea, with report that it was damaging the cowpea crop in Spottsylvania County, around Fredericksburg. The species has been observed in both States in earlier years, but this is the first instance of injury in either. A general account of it is

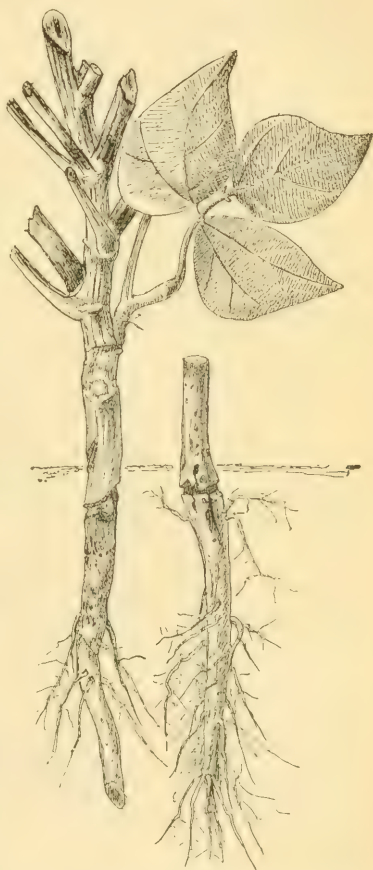


FIG. 6.—Work of larva of *Elasmopalpus lignosellus* on cowpea—reduced (original).

^a See Insect Life, Vol. I, p. 130.

given in Bulletin No. 23, (n. s.). The method of work of the larvæ in cowpea is shown in figure 6.

THE STRAWBERRY WEEVIL (*Anthrenus signatus* Say).—This, our most pernicious strawberry pest, has continued to make destructive appearances in States not previously known to have been injuriously infested. April 15, 1902, Mr. T. M. Emerson, Wilmington, N. C., reported the occurrence of this insect in that vicinity, where it had made its first appearance two or three years previously. April 27, Mr. D. B. Faison, Baltic, N. C., stated that this weevil did great damage in the eastern portion of that State. May 9 Mr. Ed. C. Sappenfield, Byrneville, Ind., reported considerable damage in that locality. Injury was noted at Rose Hill, N. C., by Mrs. F. L. Johnson, in a letter dated May 26. December 2 Mr. Ernest Walker reported considerable damage in the vicinity of Van Buren, Ark. In some instances specimens of the insect and of buds which it had injured were received, while in other cases the description of the character of the injury, which consists briefly in the puncture of the stalk bearing the strawberry bud by a minute snout-beetle and the dropping of the buds, left no doubt as to the author of the attack.

REPORT OF COMMITTEE ON RESOLUTIONS.

The report of the committee on resolutions was next called for, which is as follows:

Resolved by the Association of Economic Entomologists, That we appreciate most fully the past favors of the Department of Agriculture in publishing the proceedings of the association, and respectfully request that the proceedings of the present meetings be published as heretofore.

Resolved, That the thanks of the association be tendered to the Columbian University for the courtesy extended in the use of their building.

Resolved, That our thanks be extended to the local committee on arrangements for their successful efforts in behalf of the meeting.

Resolved, That we hereby testify to our appreciation of the hospitality of the Entomological Society of Washington.

Resolved, That our thanks are due and hereby extended to the Cosmos Club for their courtesy in entertaining members of the association.

Resolved, That we hereby acknowledge our indebtedness to the various members of the association who have contributed so largely by their papers to the success of the meeting.

F. L. WASHBURN.
AUGUST BUSCK.
W. E. RUMSEY.

It was moved and seconded that this report be adopted, and the motion prevailed.

The committee on nominations made the following report:

For president, Prof. M. V. Slingerland, Ithaca, N. Y.; for vice-president, Prof. C. M. Weed, Durham, N. H.; for second vice-president, Dr. Henry Skinner, Philadelphia, Pa.; for secretary-treasurer, Prof. A. F. Burgess, Columbus, Ohio.

To represent the Association of Economic Entomologists at the meetings of the council of the American Association for the Advancement of Science: Dr. James Fletcher, Ottawa, Canada; Dr. E. P. Felt, Albany, N. Y.

A. D. HOPKINS,
H. T. FERNALD,
A. N. CAUDELL,
Committee.

Upon motion of Mr. Weed, it was decided to hold the next meeting in connection with the American Association for the Advancement of Science, as heretofore.

Just before adjourning, Mr. Hopkins made the suggestion that the old Entomological Club of the American Association for the Advancement of Science should be resurrected. This subject was discussed at some length, and it was decided to have a meeting of the entomologists some time during the following week, to give the matter proper consideration.

There being no further business to transact, the association adjourned.

A. L. QUAINANCE, *Secretary.*

LIST OF MEMBERS OF THE ASSOCIATION OF ECONOMIC ENTOMOLOGISTS.

ACTIVE MEMBERS.

Aldrich, J. M., Agricultural Experiment Station, Moscow, Idaho.
Alwood, William B., Agricultural Experiment Station, Blacksburg, Va.
Ashmead, William H., U. S. National Museum, Washington, D. C.
Baker, C. F., Stanford University, Cal.
Ball, E. D., Agricultural Experiment Station, Logan, Utah.
Banks, C. S., Bacolod, Negros, Philippine Islands.
Banks, Nathan, U. S. Department of Agriculture, Washington, D. C.
Bethune, C. J. S., 500 Dufferin avenue, London, Ontario, Canada.
Bogue, E. E., Agricultural College, Mich.
Britton, W. E., New Haven, Conn.
Bruner, Lawrence, Agricultural Experiment Station, Lincoln, Nebr.
Burgess, Albert F., State Department of Agriculture, Columbus, Ohio.
Busck, August, U. S. Department of Agriculture, Washington, D. C.
Caudell, A. N., U. S. Department of Agriculture, Washington, D. C.
Chambliss, C. E., Clemson College, S. C.
Chittenden, F. H., U. S. Department of Agriculture, Washington, D. C.
Clifton, Richard, U. S. Department of Agriculture, Washington, D. C.
Cockerell, T. D. A., East Las Vegas, N. Mex.
Comstock, J. H., Cornell University, Ithaca, N. Y.
Cook, A. J., Pomona College, Claremont, Cal.
Cooley, R. A., Agricultural Experiment Station, Bozeman, Mont.
Coquillett, D. W., U. S. Department of Agriculture, Washington, D. C.

- Cordley, A. B., Agricultural Experiment Station, Corvallis, Oreg.
 Dyar, H. G., U. S. National Museum, Washington, D. C.
 Ehrhorn, E. M., Mountainview, Cal.
 Felt, E. P., Geologic Hall, Albany, N. Y.
 Fernald, C. H., Agricultural College, Amherst, Mass.
 Fernald, H. T., Agricultural College, Amherst, Mass.
 Fiske, W. F., U. S. Department of Agriculture, Washington, D. C.
 Fletcher, James, Central Experimental Farm, Ottawa, Canada.
 Forbes, S. A., University of Illinois, Urbana, Ill.
 Fowler, Carroll, Agricultural Experiment Station, Berkeley, Cal.
 Garman, H., Agricultural Experiment Station, Lexington, Ky.
 Gibson, Arthur, Central Experimental Farm, Ottawa, Canada.
 Gillette, C. P., Agricultural Experiment Station, Fort Collins, Colo.
 Gossard, H. A., Agricultural Experiment Station, Lake City, Fla.
 Gregson, P. B., Blackfolds, Alberta, North-West Territory.
 Hart, C. A., University of Illinois, Urbana, Ill.
 Hargitt, C. W., Syracuse University, Syracuse, N. Y.
 Heideman, Otto, U. S. Department of Agriculture, Washington, D. C.
 Hillman, F. H., U. S. Department of Agriculture, Washington, D. C.
 Hinds, W. E., U. S. Department of Agriculture, Washington, D. C.
 Hine, J. S., Ohio State University, Columbus, Ohio.
 Holland, Dr. W. J., Pittsburg, Pa.
 Hopkins, A. D., U. S. Department of Agriculture, Washington, D. C.
 Howard, L. O., U. S. Department of Agriculture, Washington, D. C.
 Hunter, S. J., University of Kansas, Lawrence, Kans.
 Hunter, W. D., U. S. Department of Agriculture, Washington, D. C.
 Kellogg, Vernon L., Stanford University, Cal.
 Kincaid, Trevor, University of Washington, Seattle, Wash.
 Kirkland, A. H., Malden, Mass.
 Kotinsky, J., U. S. Department of Agriculture, Washington, D. C.
 Lochhead, William, Guelph, Ontario.
 Lowe, V. H., Agricultural Experiment Station, Geneva, N. Y.
 Marlatt, C. L., U. S. Department of Agriculture, Washington, D. C.
 McCarthy, Gerald, care of Crop Pest Commission, Raleigh, N. C.
 Morgan, H. A., Agricultural Experiment Station, Baton Rouge, La.
 Newell, Wilmon, College Station, Tex.
 Osborn, Herbert, Ohio State University, Columbus, Ohio.
 Pergande, Th., U. S. Department of Agriculture, Washington, D. C.
 Perkins, G. H., Agricultural Experiment Station, Burlington, Vt.
 Pettit, R. H., Agricultural Experiment Station, Agricultural College, Mich.
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